WEBVTT

1 00:00:00.180 --> 00:00:01.410 <v Professor Chen>We're ready.</v>

2 00:00:01.410 --> 00:00:03.313 So let's get (indistinct), everybody.

3 00:00:04.161 --> 00:00:06.784 Thanks everyone, for (indistinct).

4 00:00:06.784 --> 00:00:10.073 It's our second (indistinct) series on (indistinct) today,

5 00:00:13.440 --> 00:00:16.534 and I'm very pleased today

6 00:00:16.534 --> 00:00:21.534 to be able to invite Dr. Evi Samoli for today's seminar.

7 00:00:22.380 --> 00:00:25.350 Dr. Samoli is Associate Professor

8 00:00:25.350 --> 00:00:28.410 of Epidemiology and Medical Statistics

9 00:00:28.410 --> 00:00:32.160 in the Medical School of the National and Kapodistrian,

10 00:00:32.160 --> 00:00:34.950 University of Athens in Greece.

11 00:00:34.950 --> 00:00:37.890 And Dr. Samoli's research interests

12 00:00:37.890 --> 00:00:40.350 focus on environmental epidemiology,

13 00:00:40.350 --> 00:00:41.880 especially the health effects

14 00:00:41.880 --> 00:00:44.422 of air pollution and climate change,

15 00:00:44.422 --> 00:00:46.530 and the development and application

16 00:00:46.530 --> 00:00:49.263 of statistical methods in related research.

17 00:00:50.130 --> 00:00:52.020 She has organized and participated

18 00:00:52.020 --> 00:00:54.270 in several statistical workshops

19 00:00:54.270 --> 00:00:56.733 and Greek and international conferences.

20 00:00:58.770 --> 00:00:59.880 She has been a reviewer

21 00:00:59.880 --> 00:01:02.310 and also a research committee member

22 00:01:02.310 --> 00:01:05.430 of the US Health Effects Institute,

23 00:01:05.430 --> 00:01:07.773 and also as for the WHO.

24 00:01:09.690 --> 00:01:14.690 She recently co-chaired this year's international conference

25 00:01:15.840 --> 00:01:20.840 for the International Society of Environmental Epidemiology.

26 00:01:20.940 --> 00:01:22.380 And her talk today will be

27 00:01:22.380 --> 00:01:25.020 Air Pollution Health Effects Under Climate Change:

28 00:01:25.020 --> 00:01:28.500 A Complex Interaction with Various Pathways.

29 00:01:28.500 --> 00:01:30.223 So without further ado, (indistinct).

30 00:01:32.800 --> 00:01:37.170 <v ->Thank you very much for the introduction, Professor Chen.</v>

31 00:01:37.170 --> 00:01:41.160 It's my pleasure to share some of the results

32 00:01:41.160 --> 00:01:42.660 with you and your class,

33 00:01:42.660 --> 00:01:44.400 and I would like to personally thank you

34 00:01:44.400 --> 00:01:46.263 for the invitation for this talk.

35 00:01:47.250 --> 00:01:51.750 Because I understand it's a rather diverse audience,

36 00:01:51.750 --> 00:01:54.090 I will focus my first slides

37 00:01:54.090 --> 00:01:56.910 on introducing the concept of air pollution,

38 00:01:56.910 --> 00:02:00.570 because as Professor Chen mentioned,

39 00:02:00.570 --> 00:02:03.540 my focus is on ambient air pollution,

40 00:02:03.540 --> 00:02:06.900 and what we know now of the health effects of air pollution,

41 00:02:06.900 --> 00:02:09.810 and then go deeper into how this interacts

42 00:02:09.810 --> 00:02:13.590 with the climate change health effects.

43 00:02:13.590 --> 00:02:16.920 Now to start with, the pollutant that we know

44 00:02:16.920 --> 00:02:20.610 has most effects on health is particulate matter

45 00:02:20.610 --> 00:02:24.673 with an aerodynamic diameter of 2.5 micrometers.

46 00:02:26.070 --> 00:02:30.513 To get you an idea of what particular matter PM 2.5 means,

47 00:02:31.350 --> 00:02:36.000 it's matter that is airborne in the air,

48 00:02:36.000 --> 00:02:40.620 and with small, so small as you can see from the graph here,

49 00:02:40.620 --> 00:02:44.970 that's smaller in fact than a red blood cell.

50 00:02:44.970 --> 00:02:48.630 So initially, we had investigated particulate matter

51 00:02:48.630 --> 00:02:53.010 that had a diameter of 10 micrometers, so was PM 10.

52 00:02:53.010 --> 00:02:56.190 But the most toxic effects of particulate matter

53 00:02:56.190 --> 00:02:58.980 are those associated with the smaller particles

54 00:02:58.980 --> 00:03:02.220 which are easier to penetrate into the lung

55 00:03:02.220 --> 00:03:04.320 from the respiratory tract

56 00:03:04.320 --> 00:03:07.620 and cause (indistinct) stress and inflammation.

57 00:03:07.620 --> 00:03:09.420 Now you must consider that

58 00:03:09.420 --> 00:03:13.263 because particulate matter is matter that is airborne,

59 00:03:14.400 --> 00:03:19.230 its composition changes according to its sources,

60 00:03:19.230 --> 00:03:23.670 and it also attracts different kind of chemical compounds

61 00:03:23.670 --> 00:03:25.500 depending on the atmosphere.

62 00:03:25.500 --> 00:03:29.970 So we have particles that are directly emitted from sources

63 00:03:29.970 --> 00:03:34.620 such as tailpipe exhaustion sources,

64 00:03:34.620 --> 00:03:38.010 or we have secondary particles formed in the atmosphere

65 00:03:38.010 --> 00:03:40.113 through chemical reactions.

66 00:03:41.400 --> 00:03:42.960 In this part of the slide,

67 00:03:42.960 --> 00:03:46.890 you can see the different figures,

68 00:03:46.890 --> 00:03:49.470 the different pictures of particulate matter

69 00:03:49.470 --> 00:03:51.450 that has different compositions.

70 00:03:51.450 --> 00:03:55.200 So for example, this is a biological source

71 00:03:55.200 --> 00:03:57.120 of particulate matter.

72 00:03:57.120 --> 00:04:00.510 The one next to it, I'm not sure if you can see my cursor,

73 00:04:00.510 --> 00:04:02.700 is my cursor visible while...

74 00:04:02.700 --> 00:04:04.530 <v ->Yes, we can see.</v> <v ->Excellent.</v>

75 00:04:04.530 --> 00:04:07.020 So this one is particulate matter

76 00:04:07.020 --> 00:04:09.720 that is emitted from tailpipes.

77 00:04:09.720 --> 00:04:12.390 It's soot particulate matter.

78 00:04:12.390 --> 00:04:17.390 This is from an unknown source, and this basically is dust.

79 00:04:18.570 --> 00:04:22.620 So not only the size of particulate matter differs,

80 00:04:22.620 --> 00:04:26.280 but also the composition differs according to sources.

81 00:04:26.280 --> 00:04:29.610 Of course, when we talk about ambient air pollution,

82 00:04:29.610 --> 00:04:32.210 apart from ambient particulate matter,

83 00:04:32.210 --> 00:04:34.560 we are exposed to a variety of gasses,

84 00:04:34.560 --> 00:04:39.010 of which the most common are nitrogen oxides

85 00:04:39.930 --> 00:04:44.930 and sulfur dioxide, carbon monoxide,

86 00:04:45.000 --> 00:04:47.460 and several hydrocarbons.

87 00:04:47.460 --> 00:04:48.630 Here in this slide,

88 00:04:48.630 --> 00:04:51.570 you can see the sources of particulate matter

89 00:04:51.570 --> 00:04:56.570 or gaseous pollutants from research in the UK,

90 00:04:56.640 --> 00:04:58.860 because you must understand

91 00:04:58.860 --> 00:05:02.310 that the main sources will differ

92 00:05:02.310 --> 00:05:05.910 according to the location, because the sources will differ.

93 00:05:05.910 --> 00:05:07.170 But in general,

94 00:05:07.170 --> 00:05:10.814 nitrogen oxides are mainly emitted from traffic,

95 00:05:10.814 --> 00:05:13.110 traffic related pollutants,

96 00:05:13.110 --> 00:05:16.560 and are emitted from tailpipe emissions,

97 00:05:16.560 --> 00:05:20.190 while particulate matter, depends on the sources,

98 00:05:20.190 --> 00:05:22.170 comes heavily from residential

99 00:05:22.170 --> 00:05:25.590 and small scale commercial combustion, as you see here.

100 00:05:25.590 --> 00:05:28.530 But also, it may be emitted from tailpipe,

101 00:05:28.530 --> 00:05:31.413 or non tailpipe sources, for example,

102 00:05:32.340 --> 00:05:34.740 they might be dust particles in the air

103 00:05:34.740 --> 00:05:38.280 that come also from the brakes

104 00:05:38.280 --> 00:05:43.280 and the tire contact of the car into the roads.

105 00:05:45.570 --> 00:05:47.340 From the gaseous pollutants,

106 00:05:47.340 --> 00:05:49.440 the one that has received most attention

107 00:05:49.440 --> 00:05:51.360 apart from nitrogen oxide,

108 00:05:51.360 --> 00:05:53.370 and the one that is most relevant

109 00:05:53.370 --> 00:05:55.980 with climate change is ozone.

110 00:05:55.980 --> 00:05:58.510 So you may be aware that ozone

111 00:05:58.510 --> 00:06:01.770 is in different strata of the atmosphere.

112 00:06:01.770 --> 00:06:04.680 When ozone is on the external atmosphere,

113 00:06:04.680 --> 00:06:06.960 what that is called the stratosphere,

114 00:06:06.960 --> 00:06:10.020 is the ozone that it's good for the environment,

115 00:06:10.020 --> 00:06:11.730 that protects, in fact,

116 00:06:11.730 --> 00:06:15.180 Earth from the sun's ultraviolet radiation.

117 00:06:15.180 --> 00:06:19.470 But when we talk about ozone in air pollution,

118 00:06:19.470 --> 00:06:23.730 we mean the ozone that is encountered in the troposphere,

119 00:06:23.730 --> 00:06:26.760 in the lower levels of the atmosphere.

120 00:06:26.760 --> 00:06:30.930 And this, in fact, is a secondary gaseous pollutant,

121 00:06:30.930 --> 00:06:35.760 because in order to form ozone in the troposphere,

122 00:06:35.760 --> 00:06:39.420 this is formed from secondary chemical reactions

123 00:06:39.420 --> 00:06:44.420 that require nitrogen oxides emitted from traffic sources

124 00:06:45.450 --> 00:06:47.610 in the presence of sunlight.

125 00:06:47.610 --> 00:06:50.310 That is why it is heavily dependent

126 00:06:50.310 --> 00:06:51.930 on climate change scenario,

127 00:06:51.930 --> 00:06:54.960 because as we expect that the heat will increase,

128 00:06:54.960 --> 00:06:58.560 the temperature will heat because of climate change,

129 00:06:58.560 --> 00:07:01.533 ozone levels are also expected to increase,

130 00:07:02.580 --> 00:07:05.430 and I will give a small presentation

131 00:07:05.430 --> 00:07:09.630 about the known health effects of these air pollutants.

132 00:07:09.630 --> 00:07:12.420 Now in general, air pollution health effects

133 00:07:12.420 --> 00:07:16.080 are very small, (indistinct) made very small relative risks

134 00:07:16.080 --> 00:07:18.483 compared to other risk factors for health.

135 00:07:19.440 --> 00:07:24.440 For example, we might estimate relative risks

136 00:07:24.450 --> 00:07:27.810 of the scale of 1.06.

137 00:07:27.810 --> 00:07:31.470 So it's a very small relative risk for human health,

138 00:07:31.470 --> 00:07:36.000 but if we consider the involuntary exposure

139 00:07:36.000 --> 00:07:38.970 of the whole population to air pollution,

140 00:07:38.970 --> 00:07:41.730 we understand why this is considered

141 00:07:41.730 --> 00:07:45.690 a major risk factor for human health.

142 00:07:45.690 --> 00:07:49.530 And this translates also to a large number

143 00:07:49.530 --> 00:07:51.750 of attributable deaths.

144 00:07:51.750 --> 00:07:53.880 So in general, in this pyramid,

145 00:07:53.880 --> 00:07:55.950 it's a classic pyramid portraying

146 00:07:55.950 --> 00:07:57.870 the effects of air pollution,

147 00:07:57.870 --> 00:07:59.970 where the majority of the population

148 00:07:59.970 --> 00:08:02.040 is in the bottom of the pyramid,

149 00:08:02.040 --> 00:08:07.040 and is expected to have only very minor symptoms.

150 00:08:07.860 --> 00:08:10.323 But as we go up to the pyramid,

151 00:08:12.150 --> 00:08:15.510 the severity of the effect increases,

152 00:08:15.510 --> 00:08:17.820 and the proportion of the population

153 00:08:17.820 --> 00:08:20.490 that is expected to experience

154 00:08:20.490 --> 00:08:23.280 these severe health effects is reduced.

155 00:08:23.280 --> 00:08:28.280 But nevertheless, because exactly the exposure is so wide,

156 00:08:28.380 --> 00:08:31.890 this is a considerable number of attributable cases,

157 00:08:31.890 --> 00:08:34.830 and that is why it's a very critical matter

158 00:08:34.830 --> 00:08:35.943 for public health.

159 00:08:37.590 --> 00:08:41.760 How do we estimate the health effects of air pollution?

160 00:08:41.760 --> 00:08:45.120 There are two kinds of ways to approach and investigate

161 00:08:45.120 --> 00:08:47.160 health effects of air pollution.

162 00:08:47.160 --> 00:08:49.350 One is short term health effects,

163 00:08:49.350 --> 00:08:52.260 meaning the health effects that are encountered

164 00:08:52.260 --> 00:08:55.950 after a few days, or at most,

165 00:08:55.950 --> 00:09:00.451 a month prior to the event that we're interested in.

166 00:09:00.451 --> 00:09:02.430 Or the long term health effects,

167 00:09:02.430 --> 00:09:06.150 meaning that the health effects that are attributed

168 00:09:06.150 --> 00:09:09.210 to cumulative exposure to air pollution, for example,

169 00:09:09.210 --> 00:09:13.860 to air pollution we're exposed to at our residence.

170 00:09:13.860 --> 00:09:17.700 And this may help, as it has been shown

171 00:09:17.700 --> 00:09:21.450 to increase the incidence of cancers,

172 00:09:21.450 --> 00:09:22.980 and particularly lung cancer.

173 00:09:22.980 --> 00:09:26.730 So there's those two ways of effects,

174 00:09:26.730 --> 00:09:29.010 either short or long-term effects.

175 00:09:29.010 --> 00:09:31.650 But nevertheless, as you may imagine,

176 00:09:31.650 --> 00:09:34.620 there's a continuing, continuing, excuse me,

177 00:09:34.620 --> 00:09:37.770 between short and long term health effects,

178 00:09:37.770 --> 00:09:41.580 that it's not completely understood.

179 00:09:41.580 --> 00:09:44.070 Short term health effects are very smaller

180 00:09:44.070 --> 00:09:45.660 compared to magnitude,

181 00:09:45.660 --> 00:09:48.753 compared to longer term health effects in general.

182 00:09:50.760 --> 00:09:55.080 You may be aware of the Global Burden of Disease project,

183 00:09:55.080 --> 00:09:59.610 that classifies risk factor for health globally

184 00:09:59.610 --> 00:10:03.480 in a periodic time periods.

185 00:10:03.480 --> 00:10:06.270 Air pollution is always classified

186 00:10:06.270 --> 00:10:09.120 on the 10 most important risk factors

187 00:10:09.120 --> 00:10:11.310 for health globally,

188 00:10:11.310 --> 00:10:15.510 either if this is accounted for in number of deaths,

189 00:10:15.510 --> 00:10:18.330 or disability adjusted years.

190 00:10:18.330 --> 00:10:20.160 In the latest classification

191 00:10:20.160 --> 00:10:22.800 of the Global Burden of Disease project,

192 00:10:22.800 --> 00:10:26.610 you may see that air pollution in terms of mortality

193 00:10:26.610 --> 00:10:30.480 was classified as the fourth risk factor,

194 00:10:30.480 --> 00:10:34.260 only below high blood pressure, smoking habits,

195 00:10:34.260 --> 00:10:38.010 and dietary habits as well.

196 00:10:38.010 --> 00:10:39.690 And it accounted for about

197 00:10:39.690 --> 00:10:42.933 6.7 million deaths annually globally.

198 00:10:43.980 --> 00:10:47.160 Now these kinds of health effects are attributed,

199 00:10:47.160 --> 00:10:51.450 and this is what is estimated underneath these figures.

200 00:10:51.450 --> 00:10:55.860 These are health effects attributed to PM 2.5,

201 00:10:55.860 --> 00:10:59.850 as I introduced it earlier, and to ozone health effects.

202 00:10:59.850 --> 00:11:02.220 These are the two pollutants

203 00:11:02.220 --> 00:11:05.943 that we have the most consistent evidence on health effects.

204 00:11:06.840 --> 00:11:11.840 For PM 2.5, basically,

205 00:11:12.030 --> 00:11:14.760 this accounts for long term health effects,

206 00:11:14.760 --> 00:11:18.437 while for ozone, we are most certain

207 00:11:20.100 --> 00:11:22.290 about its short term lung effects,

208 00:11:22.290 --> 00:11:26.340 while the longer term health effects of ozone exposure

209 00:11:26.340 --> 00:11:28.353 are still under investigation.

210 00:11:29.250 --> 00:11:31.770 What kind of disease we are talking about

211 00:11:31.770 --> 00:11:35.670 when we are talking about air pollution health effects?

212 00:11:35.670 --> 00:11:38.940 You can see here from the State of Global Air,

213 00:11:38.940 --> 00:11:42.090 that I urge you to visit, is a site

214 00:11:42.090 --> 00:11:44.850 that it's been sustained by the Health Effects Institute,

215 00:11:44.850 --> 00:11:47.610 and has similar figures

216 00:11:47.610 --> 00:11:49.980 of the levels of air pollution globally,

217 00:11:49.980 --> 00:11:52.240 or the attributable number of deaths

218 00:11:53.130 --> 00:11:56.340 attributable to PM 2.5 exposure,

219 00:11:56.340 --> 00:12:00.750 ozone exposure, or even household indoors exposure.

220 00:12:00.750 --> 00:12:05.750 So we can see that we have about 40% of COPD deaths

221 00:12:08.550 --> 00:12:11.910 attributed to PM 2.5.

222 00:12:11.910 --> 00:12:15.540 20% about from diabetes deaths

223 00:12:15.540 --> 00:12:17.940 are attributed to air pollution.

224 00:12:17.940 --> 00:12:20.100 20% of ischemic heart disease,

225 00:12:20.100 --> 00:12:22.920 or lower respiratory infections.

226 00:12:22.920 --> 00:12:27.180 About 20% of lung cancer cases are also attributed

227 00:12:27.180 --> 00:12:32.180 to ambient air pollution, and also to neonatal deaths,

228 00:12:32.550 --> 00:12:35.103 it's a similar percentage, or stroke.

229 00:12:37.500 --> 00:12:39.417 Following these severe health effects

230 00:12:39.417 --> 00:12:41.010 for the general population

231 00:12:41.010 --> 00:12:43.565 and the importance in public health.

232 00:12:43.565 --> 00:12:48.565 WHO releases air quality guidelines regularly,

233 00:12:48.630 --> 00:12:51.180 and in the last month,

234 00:12:51.180 --> 00:12:56.180 it has released the more strict guidelines,

235 00:12:56.940 --> 00:13:00.820 requiring air pollutant levels for PM 2.5

236 00:13:01.680 --> 00:13:04.770 to be less than five micrograms per cubic meter.

237 00:13:04.770 --> 00:13:07.983 This is a mean year average.

238 00:13:08.983 --> 00:13:12.750 PM 10 is a bit higher, it's 15 micrograms,

239 00:13:12.750 --> 00:13:14.220 the limit suggested.

240 00:13:14.220 --> 00:13:18.990 For ozone, you can see it's 60 micrograms per cubic meter.

241 00:13:18.990 --> 00:13:23.220 Ozone usually is measured in the US in parts per billion.

242 00:13:23.220 --> 00:13:25.863 So you may see the units in PPB.

243 00:13:26.850 --> 00:13:29.580 And the nitrogen dioxide is about

244 00:13:29.580 --> 00:13:34.560 10 micrograms per cubic meter as a annual average.

245 00:13:34.560 --> 00:13:39.560 24 daily averages are always a bit larger.

246 00:13:42.780 --> 00:13:47.480 Now how do this compare to the existing levels

247 00:13:47.480 --> 00:13:48.420 of air pollutants?

248 00:13:48.420 --> 00:13:51.060 I may assure you that both for US

249 00:13:51.060 --> 00:13:55.770 and the large majority of European countries,

250 00:13:55.770 --> 00:14:00.770 these are lower than the existing levels of air pollution,

251 00:14:00.780 --> 00:14:04.110 considering the year averages.

252 00:14:04.110 --> 00:14:06.690 The WHO air guidelines

253 00:14:06.690 --> 00:14:11.690 are not legislative binding for the countries.

254 00:14:12.840 --> 00:14:16.080 They're based on protecting public health,

255 00:14:16.080 --> 00:14:21.080 and then the area specific authorities

256 00:14:22.470 --> 00:14:24.360 release their own guidelines,

257 00:14:24.360 --> 00:14:28.650 taking into account not only the interest of public health

258 00:14:28.650 --> 00:14:31.980 and how this is reflected in the WHO guidelines,

259 00:14:31.980 --> 00:14:34.740 but also, as you may imagine, other aspects

260 00:14:34.740 --> 00:14:38.190 such as the cost benefit fractions,

261 00:14:38.190 --> 00:14:41.670 and how would this impact the economy

262 00:14:41.670 --> 00:14:45.390 in order to lower the levels in terms of productivity,

263 00:14:45.390 --> 00:14:48.000 industry, and so on, and so on.

264 00:14:48.000 --> 00:14:53.000 So here, in this slide, you will see the limit values

265 00:14:53.160 --> 00:14:56.940 that are currently existing,

266 00:14:56.940 --> 00:15:00.240 both in the European Commission on the left,

267 00:15:00.240 --> 00:15:03.750 and UN's on the right that you can see.

268 00:15:03.750 --> 00:15:06.510 The levels are higher than those

269 00:15:06.510 --> 00:15:09.660 that are proposed by the WHO.

270 00:15:09.660 --> 00:15:14.430 For example, for PM 2.5, you can see here,

271 00:15:14.430 --> 00:15:19.080 depending on the source, that EPA suggested limit values

272 00:15:19.080 --> 00:15:21.240 are very much higher

273 00:15:21.240 --> 00:15:23.560 than the five micrograms per cubic meter

274 00:15:24.450 --> 00:15:29.450 proposed by WHO, while for the same pollutant and metric

275 00:15:32.880 --> 00:15:36.810 in Europe, we have even larger limit values.

276 00:15:36.810 --> 00:15:41.010 These are the legislative binding limit values

277 00:15:41.010 --> 00:15:42.300 for the state members.

278 00:15:42.300 --> 00:15:47.040 So in Europe, for example, if we exceed this kind of limit,

279 00:15:47.040 --> 00:15:52.040 we are under fine to the European Commission.

280 00:15:53.100 --> 00:15:56.760 And nevertheless, it's clear that this is not a measure

281 00:15:56.760 --> 00:15:58.020 that protects public health,

282 00:15:58.020 --> 00:16:01.620 and it's a big pressure nowadays to lower the limits,

283 00:16:01.620 --> 00:16:04.203 both in US and the European Union.

284 00:16:06.120 --> 00:16:07.980 So coming into the interplay

285 00:16:07.980 --> 00:16:10.500 with climate change health effects.

286 00:16:10.500 --> 00:16:14.520 We know that the climate change health effects

287 00:16:14.520 --> 00:16:17.550 can be either direct or indirect.

288 00:16:17.550 --> 00:16:20.580 For example, we have direct health effects

289 00:16:20.580 --> 00:16:23.310 due to climate change extreme events,

290 00:16:23.310 --> 00:16:27.390 such as heat strokes under heat waves,

291 00:16:27.390 --> 00:16:31.620 or we may have fatalities in wildfires

292 00:16:31.620 --> 00:16:33.750 and similar extreme events.

293 00:16:33.750 --> 00:16:35.923 But we also have indirect health effects

294 00:16:35.923 --> 00:16:38.730 attributed to climate change,

295 00:16:38.730 --> 00:16:41.580 because climate change impacts also

296 00:16:41.580 --> 00:16:45.480 the quality of the air,

297 00:16:45.480 --> 00:16:48.390 so it worsens the levels of air pollutants.

298 00:16:48.390 --> 00:16:51.930 Hence, we have this indirect effect

299 00:16:51.930 --> 00:16:56.160 from increasing the health effects of air pollution

300 00:16:56.160 --> 00:16:57.843 that I mentioned earlier.

301 00:16:59.010 --> 00:17:02.100 I will show in the later slides

302 00:17:02.100 --> 00:17:06.030 that this is a much more complex interaction

303 00:17:06.030 --> 00:17:09.330 between climate change events and air pollutants.

304 00:17:09.330 --> 00:17:11.520 It also has indirect health effects,

305 00:17:11.520 --> 00:17:16.520 because climate change impacts also public health services.

306 00:17:17.520 --> 00:17:21.510 So the public health sector is not ready

307 00:17:21.510 --> 00:17:24.673 to accommodate the extra events

308 00:17:24.673 --> 00:17:27.210 attributed to climate change extreme events,

309 00:17:27.210 --> 00:17:30.630 but also to the entire effect that follow

310 00:17:30.630 --> 00:17:32.043 climate change events.

311 00:17:34.110 --> 00:17:37.530 This comes from a report in the European Commission

312 00:17:37.530 --> 00:17:41.940 that somehow schematically illustrates what you may know,

313 00:17:41.940 --> 00:17:45.270 that temperature has effects on human health.

314 00:17:45.270 --> 00:17:47.790 We know that, for example,

315 00:17:47.790 --> 00:17:52.230 mortality occurs in low temperatures or in high temperature.

316 00:17:52.230 --> 00:17:55.980 The shape between temperature levels and health

317 00:17:55.980 --> 00:17:58.680 is a parabola, a U shape,

318 00:17:58.680 --> 00:18:02.190 where we see increasing events in the very low temperatures,

319 00:18:02.190 --> 00:18:05.490 as you may imagine, or the very high temperatures.

320 00:18:05.490 --> 00:18:09.227 So temperature has a direct effect on human health.

321 00:18:10.073 --> 00:18:13.860 And in fact, the temperature effects on health

322 00:18:13.860 --> 00:18:15.990 are more strong in magnitude

323 00:18:15.990 --> 00:18:20.223 than the effects of air pollution that I mentioned earlier.

324 00:18:21.450 --> 00:18:24.780 As you may see from the report of the European Commission,

325 00:18:24.780 --> 00:18:27.510 there's a geographical variability

326 00:18:27.510 --> 00:18:30.870 in the health effects of temperature,

327 00:18:30.870 --> 00:18:33.930 and generally of climate change.

328 00:18:33.930 --> 00:18:37.500 We have more severe effects in hotter climates,

329 00:18:37.500 --> 00:18:40.500 such as the southern Europe

330 00:18:40.500 --> 00:18:42.900 compared to the northern European countries.

331 00:18:42.900 --> 00:18:46.350 And we have also, not only geographical probability,

332 00:18:46.350 --> 00:18:48.390 but we have a (indistinct) effect

333 00:18:48.390 --> 00:18:52.350 depending on the subpopulation groups we are interested in.

334 00:18:52.350 --> 00:18:56.850 So people that are usually more sensitive

335 00:18:56.850 --> 00:19:00.480 to meteorological and air pollution health effects

336 00:19:00.480 --> 00:19:02.880 are children, pregnant women,

337 00:19:02.880 --> 00:19:07.880 and elderly citizens, or people with preexisting diseases.

338 00:19:11.640 --> 00:19:16.307 Why now climate change has a more complex pathway

339 00:19:17.700 --> 00:19:20.010 to health through air pollution?

340 00:19:20.010 --> 00:19:25.010 Because air pollution emissions also are a contributor

341 00:19:25.830 --> 00:19:29.850 to climate change events.

342 00:19:29.850 --> 00:19:33.510 So emissions increase temperature,

343 00:19:33.510 --> 00:19:37.200 that constitutes part of climate change,

344 00:19:37.200 --> 00:19:39.540 and this, in fact, the increase in temperature,

345 00:19:39.540 --> 00:19:41.853 as I mentioned in the beginning of the talk,

346 00:19:42.720 --> 00:19:45.210 is necessary to produce more ozone,

347 00:19:45.210 --> 00:19:49.470 that is also known to have adverse health effects

348 00:19:49.470 --> 00:19:50.970 to human health.

349 00:19:50.970 --> 00:19:52.590 There are also interactions

350 00:19:52.590 --> 00:19:54.660 between temperature and air pollution,

351 00:19:54.660 --> 00:19:58.280 meaning that we have higher effects of temperature

352 00:19:58.280 --> 00:20:00.270 in more polluted areas,

353 00:20:00.270 --> 00:20:04.500 or we have higher effects of air pollution in warmer areas.

354 00:20:04.500 --> 00:20:09.480 This still now have traditionally been studied separately,

355 00:20:09.480 --> 00:20:14.250 but because of the complex interplay between climate change,

356 00:20:14.250 --> 00:20:18.210 and particularly temperature levels and air pollution,

357 00:20:18.210 --> 00:20:19.740 in the recent years,

358 00:20:19.740 --> 00:20:23.130 this have received increasing attention,

359 00:20:23.130 --> 00:20:25.170 and more publications are coming up,

360 00:20:25.170 --> 00:20:28.190 and I will just go through some main publications

361 00:20:28.190 --> 00:20:30.723 on the topic in the later slides.

362 00:20:31.740 --> 00:20:34.560 Apart from this interplay

363 00:20:34.560 --> 00:20:37.593 between temperature and air pollution,

364 00:20:38.580 --> 00:20:40.530 we know that climate change

365 00:20:40.530 --> 00:20:44.730 increases the occurrence of wildfires.

366 00:20:44.730 --> 00:20:48.360 Wildfires are a main source of emission

367 00:20:48.360 --> 00:20:50.670 of particulate matter in the air.

368 00:20:50.670 --> 00:20:52.410 For example, you may recall

369 00:20:52.410 --> 00:20:57.060 the very intense wildfires that burnt over California,

370 00:20:57.060 --> 00:20:59.010 I think this was two years ago.

371 00:20:59.010 --> 00:21:01.560 The smoke reached all the way

372 00:21:01.560 --> 00:21:03.660 up to the east coast of the US.

373 00:21:03.660 --> 00:21:06.630 So we have the source of wildfires

374 00:21:06.630 --> 00:21:11.130 that not only impacts the location where wildfire occurs,

375 00:21:11.130 --> 00:21:15.600 but also depending on the wind direction and the atmosphere,

376 00:21:15.600 --> 00:21:20.600 atmospheric reaction, may also impact air quality levels

377 00:21:21.210 --> 00:21:23.493 in further distances.

378 00:21:25.020 --> 00:21:26.580 Further up to that,

379 00:21:26.580 --> 00:21:30.600 climate change is expected to increase drought,

380 00:21:30.600 --> 00:21:35.490 and also the frequency of desert dust episodes.

381 00:21:35.490 --> 00:21:36.690 I told you in the beginning

382 00:21:36.690 --> 00:21:38.610 that one source of particulate matter

383 00:21:38.610 --> 00:21:40.980 in ambient air is dust.

384 00:21:40.980 --> 00:21:44.490 So we have occurrences of desert dust transport,

385 00:21:44.490 --> 00:21:47.670 for example, in Greece, and in the southern of Europe,

386 00:21:47.670 --> 00:21:50.730 we have desert dust transport,

387 00:21:50.730 --> 00:21:53.820 traditionally during spring or early summer,

388 00:21:53.820 --> 00:21:55.860 from the Sahara area.

389 00:21:55.860 --> 00:21:58.590 Depending on meteorological conditions,

390 00:21:58.590 --> 00:22:00.690 Sahara area has been shown

391 00:22:00.690 --> 00:22:03.210 also to reach the east coast of US sometimes.

392 00:22:03.210 --> 00:22:06.420 So these kinds of desert dust episodes

393 00:22:06.420 --> 00:22:11.420 are expected to increase both in frequency and duration.

394 00:22:12.120 --> 00:22:15.960 Apart from that, also the fact that climate change

395 00:22:15.960 --> 00:22:18.300 increases drought,

396 00:22:18.300 --> 00:22:21.090 we can understand that this also will increase

397 00:22:21.090 --> 00:22:25.893 suspended particles from dust sources.

398 00:22:28.020 --> 00:22:31.650 This publication is a nice figure,

399 00:22:31.650 --> 00:22:36.650 also graphically showing this direct and indirect effects

400 00:22:36.900 --> 00:22:40.350 between climate change and, in fact,

401 00:22:40.350 --> 00:22:44.487 the focus of this publication was cardiovascular mortality,

402 00:22:46.410 --> 00:22:49.800 because you may know that cardiovascular mortality

403 00:22:49.800 --> 00:22:54.800 typically consists about 30 to 40% of total mortality.

404 00:22:56.160 --> 00:22:59.640 So we can see that from climate change

405 00:22:59.640 --> 00:23:02.880 can have a direct effect to cardiovascular...

406 00:23:02.880 --> 00:23:06.720 Climate change leads to extreme temperature.

407 00:23:06.720 --> 00:23:11.720 Extreme temperature may cause cardiovascular inflammation,

408 00:23:12.330 --> 00:23:14.860 that will lead to cardiovascular mortality

409 00:23:16.110 --> 00:23:17.820 through direct effect,

410 00:23:17.820 --> 00:23:21.600 but also through increases in the ozone levels,

411 00:23:21.600 --> 00:23:25.830 that we know has impacts on cardiovascular mortality,

412 00:23:25.830 --> 00:23:28.773 has an indirect weight towards there.

413 00:23:29.610 --> 00:23:31.710 As mentioned earlier, also,

414 00:23:31.710 --> 00:23:36.300 the wildfires will increase due to climate change,

415 00:23:36.300 --> 00:23:41.300 and wildfires basically are causing increases

416 00:23:42.000 --> 00:23:46.443 in the levels of nitrogen dioxide and particulate matter,

417 00:23:47.345 --> 00:23:51.840 and in a specific chemical composition of particulate matter

418 00:23:51.840 --> 00:23:53.490 that is black carbon

419 00:23:53.490 --> 00:23:57.930 because when solid fuel produces black carbon,

420 00:23:57.930 --> 00:24:00.660 which is one of the constituents,

421 00:24:00.660 --> 00:24:04.470 possible constituents of ambient particulate matter,

422 00:24:04.470 --> 00:24:06.330 that from research until now

423 00:24:06.330 --> 00:24:09.750 has been shown to be one of the most toxic components

424 00:24:09.750 --> 00:24:11.370 of particulate matter.

425 00:24:11.370 --> 00:24:16.370 So wildfire is expected to affect cardiovascular mortality,

426 00:24:17.220 --> 00:24:20.820 again through the same biological pathway,

427 00:24:20.820 --> 00:24:25.560 either by increasing nitrogen dioxide particulate matter,

428 00:24:25.560 --> 00:24:28.170 and when nitrogen dioxide increases,

429 00:24:28.170 --> 00:24:30.120 because it's a necessary

430 00:24:30.120 --> 00:24:32.850 ingredient for the formation of stratospheric ozone,

431 00:24:32.850 --> 00:24:35.643 also ozone will increase.

432 00:24:38.100 --> 00:24:43.100 This is a very nice graph from a current European project

433 00:24:43.260 --> 00:24:45.030 we are running.

434 00:24:45.030 --> 00:24:47.340 Professor Chen is aware of this,

435 00:24:47.340 --> 00:24:52.340 and this has been a graphical display exactly

436 00:24:52.800 --> 00:24:55.650 of the impact of climate change on air pollution

437 00:24:55.650 --> 00:24:57.690 and related health effects,

438 00:24:57.690 --> 00:25:02.690 in order to communicate this to the general public.

439 00:25:02.790 --> 00:25:06.120 So you can see, again, that the title, I think,

440 00:25:06.120 --> 00:25:09.990 is very good for commercial and scientific reasons.

441 00:25:09.990 --> 00:25:12.330 We breathe climate change.

442 00:25:12.330 --> 00:25:15.000 So the impact on cardiovascular mortality

443 00:25:15.000 --> 00:25:16.800 comes from heat waves,

444 00:25:16.800 --> 00:25:20.430 tropospheric or ground level ozone particulate matter,

445 00:25:20.430 --> 00:25:24.180 wildfires, and then we have the health impacts,

446 00:25:24.180 --> 00:25:28.140 that especially in Europe, it has been estimated

447 00:25:28.140 --> 00:25:33.140 that air pollution may cause up to 800,000 premature deaths.

448 00:25:37.200 --> 00:25:38.433 Oops, I'm sorry.

449 00:25:40.200 --> 00:25:43.920 A few words, what we mean

450 00:25:43.920 --> 00:25:46.620 when we talk about ozone health effects.

451 00:25:46.620 --> 00:25:49.650 This is the results of the global study

452 00:25:49.650 --> 00:25:53.190 on the short term exposure to ozone,

453 00:25:53.190 --> 00:25:56.130 and all cause mortality.

454 00:25:56.130 --> 00:25:59.460 In the figure in the left, you may see the countries

455 00:25:59.460 --> 00:26:04.460 that provided data to the specific study,

456 00:26:04.620 --> 00:26:06.387 and here you can see per country,

457 00:26:06.387 --> 00:26:09.930 the number of cities that contributed to data.

458 00:26:09.930 --> 00:26:14.930 We had 188 cities from US that contributed data.

459 00:26:15.720 --> 00:26:18.120 You can see that US contributes

460 00:26:18.120 --> 00:26:20.400 a lot of ozone and mortality data,

461 00:26:20.400 --> 00:26:23.250 and also a lot of European cities

462 00:26:23.250 --> 00:26:25.170 contributed relevant data,

463 00:26:25.170 --> 00:26:29.400 and we had fewer countries in the Eastern Asia,

464 00:26:29.400 --> 00:26:34.200 a few in Asia and in Africa, and some in Australia.

465 00:26:34.200 --> 00:26:38.400 The figure shows the different levels of ozone,

466 00:26:38.400 --> 00:26:42.510 and here, you can see what the estimates,

467 00:26:42.510 --> 00:26:46.350 the relative risks in total mortality

468 00:26:46.350 --> 00:26:50.880 for a 10 micrograms per cubic meter increase in ozone.

469 00:26:50.880 --> 00:26:54.780 So this is short term health effects of ozone.

470 00:26:54.780 --> 00:26:57.870 It's the previous day ozone,

471 00:26:57.870 --> 00:27:01.800 and how this will increase the next day

472 00:27:01.800 --> 00:27:03.990 total mortality in the cities.

473 00:27:03.990 --> 00:27:07.860 And you can see, for example, that in the United States,

474 00:27:07.860 --> 00:27:11.010 the 10 micrograms increase in ozone

475 00:27:11.010 --> 00:27:15.840 is associated with about 0.2% increase

476 00:27:15.840 --> 00:27:17.430 in daily number of deaths.

477 00:27:17.430 --> 00:27:22.430 0.2% increase is a small increase in terms of magnitude.

478 00:27:24.120 --> 00:27:27.960 But when we translate this into number of deaths,

479 00:27:27.960 --> 00:27:32.010 you can see that this is a large number of deaths.

480 00:27:32.010 --> 00:27:37.010 For example, if ozone exceeds the guideline from WHO,

481 00:27:38.534 --> 00:27:42.930 at that point was 100 micrograms per cubic meter in the US,

482 00:27:42.930 --> 00:27:47.930 this was attributed to about 200 annual excess deaths

483 00:27:48.543 --> 00:27:51.900 attributed to ozone short term exposure.

484 00:27:51.900 --> 00:27:56.900 And this, in fact, was a 0.4% increase in total mortality.

485 00:27:57.360 --> 00:28:02.360 So about, rather, a large percent of total mortality

486 00:28:05.053 --> 00:28:08.940 could be attributed to ozone exposure.

487 00:28:08.940 --> 00:28:10.200 You can also see that

488 00:28:10.200 --> 00:28:13.290 depending on the area of the world analyzed,

489 00:28:13.290 --> 00:28:15.900 the magnitude of effects differed.

490 00:28:15.900 --> 00:28:20.900 Okay, for example, in Athens, that's a smaller country,

491 00:28:22.470 --> 00:28:26.130 sorry, smaller city, because we only contributed one city

492 00:28:26.130 --> 00:28:30.660 to the analysis, compared to Los Angeles, for example,

493 00:28:30.660 --> 00:28:35.400 but is the estimate here, we have fewer number of deaths,

494 00:28:35.400 --> 00:28:37.743 because we have a smaller population.

495 00:28:39.570 --> 00:28:42.870 Especially for USA, it has been estimated

496 00:28:42.870 --> 00:28:47.100 that one to four degrees Celsius increase

497 00:28:47.100 --> 00:28:51.210 in mean daily temperature will lead to an increase

498 00:28:51.210 --> 00:28:56.100 of ozone levels by one to five parts per billion.

499 00:28:56.100 --> 00:29:01.100 This is about 10 micrograms per cubic meter increase,

500 00:29:01.140 --> 00:29:02.910 and this is expected to account

501 00:29:02.910 --> 00:29:05.940 for tens of thousands of hospitalizations

502 00:29:05.940 --> 00:29:10.380 and deaths annually by 2030.

503 00:29:10.380 --> 00:29:13.770 It has also been an estimate,

504 00:29:13.770 --> 00:29:16.830 because you may recall that in 2003,

505 00:29:16.830 --> 00:29:19.473 we had a major heat wave in Europe,

506 00:29:21.210 --> 00:29:24.780 when a lot of excess deaths were attributed exactly

507 00:29:24.780 --> 00:29:27.540 to the effect of this heat wave.

508 00:29:27.540 --> 00:29:30.420 There was a recent study indicating

509 00:29:30.420 --> 00:29:34.140 that about half of these effects of these deaths

510 00:29:34.140 --> 00:29:37.290 could be attributed to the ozone exposure

511 00:29:37.290 --> 00:29:42.290 that increased exactly because of this extreme heat days.

512 00:29:45.450 --> 00:29:49.980 This is one of the first studies to address,

513 00:29:49.980 --> 00:29:52.350 is a study by Professor Chen, in fact,

514 00:29:52.350 --> 00:29:54.000 and it's one of the first studies

515 00:29:54.000 --> 00:29:57.153 to simultaneously assess the interaction,

516 00:29:57.153 --> 00:29:59.580 the interplay between temperature levels

517 00:29:59.580 --> 00:30:01.560 and air pollution levels,

518 00:30:01.560 --> 00:30:04.430 and their impact on the daily mortality.

519 00:30:04.430 --> 00:30:09.243 It was an analysis that incorporated data from,

520 00:30:10.170 --> 00:30:14.010 you can see, eight different areas in Europe,

521 00:30:14.010 --> 00:30:16.770 spanning from Finland to Greece.

522 00:30:16.770 --> 00:30:21.390 So we had cities from northern Europe,

523 00:30:21.390 --> 00:30:24.450 central Europe, and southern Europe,

524 00:30:24.450 --> 00:30:28.380 and the table below shows the results,

525 00:30:28.380 --> 00:30:32.190 how the air pollution health effects differ

526 00:30:32.190 --> 00:30:35.280 according to different levels of air pollution.

527 00:30:35.280 --> 00:30:37.290 Just to briefly mention,

528 00:30:37.290 --> 00:30:40.800 we have the previous day ozone health effects,

529 00:30:40.800 --> 00:30:43.620 the previous day PM 10 health effects,

530 00:30:43.620 --> 00:30:47.280 the previous day PM 2.5 health effects,

531 00:30:47.280 --> 00:30:50.848 and PNC are even smaller particles.

532 00:30:50.848 --> 00:30:55.410 It's a metric to study ultra fine particles,

533 00:30:55.410 --> 00:30:59.460 that are particles that have a diameter

534 00:30:59.460 --> 00:31:03.920 even smaller than 0.1 micrometer.

535 00:31:05.760 --> 00:31:08.310 So if you see a bit closer,

536 00:31:08.310 --> 00:31:11.460 the percent increase of mortality

537 00:31:11.460 --> 00:31:13.950 attributed to each pollutant

538 00:31:13.950 --> 00:31:16.950 depending on the levels of temperature,

539 00:31:16.950 --> 00:31:19.680 we can see steadily that there is a trend

540 00:31:19.680 --> 00:31:23.550 that we have higher effects for all air pollution,

541 00:31:23.550 --> 00:31:25.650 for all air pollutants studied

542 00:31:25.650 --> 00:31:29.760 when air temperature levels are higher.

543 00:31:29.760 --> 00:31:33.153 And the same goes for cardiovascular deaths.

544 00:31:35.280 --> 00:31:38.040 Following this study by Professor Chen,

545 00:31:38.040 --> 00:31:39.930 there have been many other studies

546 00:31:39.930 --> 00:31:41.250 following the same rationale,

547 00:31:41.250 --> 00:31:43.170 and investigating this interaction

548 00:31:43.170 --> 00:31:45.030 between temperature and air pollutants.

549 00:31:45.030 --> 00:31:48.780 And this is a nice review of several studies

550 00:31:48.780 --> 00:31:53.700 across the globe that have tried to assess

551 00:31:53.700 --> 00:31:58.140 the interaction between particles and temperature,

552 00:31:58.140 --> 00:32:02.400 and try to estimate future attributable events

553 00:32:02.400 --> 00:32:05.370 depending on emission scenarios,

554 00:32:05.370 --> 00:32:09.273 both for air pollution and future climatic scenarios.

555 00:32:10.830 --> 00:32:14.010 I see that we are running a bit out of time,

556 00:32:14.010 --> 00:32:17.220 so I will go very quickly through this.

557 00:32:17.220 --> 00:32:18.660 We have the slides,

558 00:32:18.660 --> 00:32:22.110 and you can follow up the references if needed,

559 00:32:22.110 --> 00:32:24.780 but depending on the area,

560 00:32:24.780 --> 00:32:28.050 you can see that we have different air pollutants

561 00:32:28.050 --> 00:32:29.910 that have been assessed.

562 00:32:29.910 --> 00:32:33.810 The majority of the studies assess the effects of ozone,

563 00:32:33.810 --> 00:32:36.900 and in all of them that assess the effects of ozone

564 00:32:36.900 --> 00:32:38.610 under different scenarios,

565 00:32:38.610 --> 00:32:41.153 assessed an increase in attributable cases

566 00:32:41.153 --> 00:32:43.080 to ozone exposure.

567 00:32:43.080 --> 00:32:45.780 Attributable cases to particle exposure

568 00:32:45.780 --> 00:32:48.180 depending on emissions of air pollution

569 00:32:48.180 --> 00:32:50.100 and climate change scenarios

570 00:32:50.100 --> 00:32:53.010 differed according to the study.

571 00:32:53.010 --> 00:32:56.884 We had peaks of particulate matter related deaths,

572 00:32:56.884 --> 00:32:58.140 then deaths stabilized,

573 00:32:58.140 --> 00:32:59.670 or depending on the scenario,

574 00:32:59.670 --> 00:33:04.023 this was not such a consistent pattern as was for ozone.

575 00:33:05.310 --> 00:33:07.530 In any case, the authors urge

576 00:33:07.530 --> 00:33:10.980 that future scenarios to try to account

577 00:33:10.980 --> 00:33:14.610 for both changes in emissions,

578 00:33:14.610 --> 00:33:18.990 because we have transitioned, for example,

579 00:33:18.990 --> 00:33:23.990 from solid fuel to the electric fleet for traffic,

580 00:33:24.060 --> 00:33:26.400 but also to different measures

581 00:33:26.400 --> 00:33:30.150 that will account for different emissions

582 00:33:30.150 --> 00:33:33.690 that will change future climate change scenarios

583 00:33:33.690 --> 00:33:35.823 and associated temperature levels.

584 00:33:36.870 --> 00:33:40.080 This is a systematic review and meta-analysis

585 00:33:40.080 --> 00:33:41.940 trying to assess the evidence

586 00:33:41.940 --> 00:33:44.760 on the combined effects between air pollution,

587 00:33:44.760 --> 00:33:47.310 temperature, and pollen exposure.

588 00:33:47.310 --> 00:33:49.470 I will not go very much in depth,

589 00:33:49.470 --> 00:33:54.470 but this table shows a summary of the results

590 00:33:54.570 --> 00:33:57.270 that started all three exposures together,

591 00:33:57.270 --> 00:33:59.160 because climate change impact,

592 00:33:59.160 --> 00:34:02.190 my talk is focused on human health,

593 00:34:02.190 --> 00:34:06.780 but of course, climate change has impact on agriculture,

594 00:34:06.780 --> 00:34:10.620 and this is expected also to increase

595 00:34:10.620 --> 00:34:14.160 certain levels of pollen, that is also, as we know,

596 00:34:14.160 --> 00:34:16.920 associated with respiratory effects.

597 00:34:16.920 --> 00:34:20.910 So the authors only managed to appraise six studies

598 00:34:20.910 --> 00:34:24.210 that assessed the three exposures altogether,

599 00:34:24.210 --> 00:34:26.940 and depending on certain criteria

600 00:34:26.940 --> 00:34:29.760 of consistency of the evidence

601 00:34:29.760 --> 00:34:33.270 of the cumulative effect of these three exposures,

602 00:34:33.270 --> 00:34:36.707 concluded that overall, there was low quality

603 00:34:36.707 --> 00:34:40.980 in the evidence to support interactive effects

604 00:34:40.980 --> 00:34:43.710 of all air pollutants,

605 00:34:43.710 --> 00:34:47.250 but there was some limited evidence for indications

606 00:34:47.250 --> 00:34:49.083 of interaction effects.

607 00:34:50.340 --> 00:34:55.340 They figured that there was a much larger literature

608 00:34:55.410 --> 00:34:57.660 that had assessed both heat effects

609 00:34:57.660 --> 00:35:00.000 and air pollution simultaneously,

610 00:35:00.000 --> 00:35:03.930 and they managed to gather 39 studies

611 00:35:03.930 --> 00:35:07.140 that assess the interactive effects on both.

612 00:35:07.140 --> 00:35:11.220 And the conclusion of this systematical use

613 00:35:11.220 --> 00:35:15.480 is that, in fact, there was a moderate quality of evidence

614 00:35:15.480 --> 00:35:20.480 that those response relationships in a number of studies

615 00:35:21.810 --> 00:35:25.530 was moderate, but there was sufficient evidence

616 00:35:25.530 --> 00:35:27.690 that there was synergistic effects

617 00:35:27.690 --> 00:35:30.750 between heat and air pollution exposures,

618 00:35:30.750 --> 00:35:33.603 specifically for ozone and particulate matter.

619 00:35:36.060 --> 00:35:40.380 This is a nice review on the climate change impact

620 00:35:40.380 --> 00:35:45.307 on human health and agricultural effects, productivity,

621 00:35:46.800 --> 00:35:50.370 and of course, the different impacts are studied

622 00:35:50.370 --> 00:35:52.260 according to different designs,

623 00:35:52.260 --> 00:35:54.718 and you can see that we have mainly, of course,

624 00:35:54.718 --> 00:35:58.770 observational studies assessing the impact

625 00:35:58.770 --> 00:36:02.190 on human health, and mostly,

626 00:36:02.190 --> 00:36:04.920 when we talk about temperature and air pollution,

627 00:36:04.920 --> 00:36:09.060 I forgot to point out we are focusing on short term,

628 00:36:09.060 --> 00:36:12.180 because we know that temperature has a short term

629 00:36:12.180 --> 00:36:15.180 of human health, and in fact,

630 00:36:15.180 --> 00:36:19.350 high warm temperature have a effect on health,

631 00:36:19.350 --> 00:36:21.900 meaning have increasing hospitalizations

632 00:36:21.900 --> 00:36:25.140 due to cardiovascular or respiratory causes,

633 00:36:25.140 --> 00:36:28.380 or increase in cardiorespiratory mortality

634 00:36:28.380 --> 00:36:30.630 that spans from the same day

635 00:36:30.630 --> 00:36:33.510 up to three days later than the events,

636 00:36:33.510 --> 00:36:36.300 while the effect of the cold temperature

637 00:36:36.300 --> 00:36:39.690 is expected to have a much longer impact.

638 00:36:39.690 --> 00:36:44.400 So we may observe hospitalization and mortality counts

639 00:36:44.400 --> 00:36:48.330 associated with cold effects even following

640 00:36:48.330 --> 00:36:53.330 two weeks after the cold effect, the cold level observed.

641 00:36:54.360 --> 00:36:57.690 So in any case, when we talk about interaction

642 00:36:57.690 --> 00:37:00.510 between temperature and air pollution,

643 00:37:00.510 --> 00:37:04.740 we are focusing on short term health effects of both.

644 00:37:04.740 --> 00:37:09.510 And in this review, also, it pointed out several designs,

645 00:37:09.510 --> 00:37:12.330 and how this was studied both on human health

646 00:37:12.330 --> 00:37:14.460 and agricultural impacts,

647 00:37:14.460 --> 00:37:17.130 and there was this nice figure

648 00:37:17.130 --> 00:37:19.830 showing that temperature does modify

649 00:37:19.830 --> 00:37:21.570 air pollution impacts on health

650 00:37:21.570 --> 00:37:26.190 depending on the area, the pollutant studied,

651 00:37:27.300 --> 00:37:30.123 or the methodological parameters studied,

652 00:37:31.050 --> 00:37:33.630 and that contributed to climate change effect,

653 00:37:33.630 --> 00:37:35.250 and also the vice versa,

654 00:37:35.250 --> 00:37:39.213 that air pollution also modified temperature health effects.

655 00:37:42.660 --> 00:37:47.167 I prefer to briefly show you some results.

656 00:37:50.340 --> 00:37:54.030 This is unpublished work, sorry about this.

657 00:37:54.030 --> 00:37:57.750 This is unpublished work for, again, a global study.

658 00:37:57.750 --> 00:38:01.560 You can see that this study includes about 500 cities

659 00:38:01.560 --> 00:38:04.470 spanning across the globe from 32 studies

660 00:38:04.470 --> 00:38:08.880 that contributed data on air pollution and temperature,

661 00:38:08.880 --> 00:38:13.380 and in fact, present results for the interaction effect

662 00:38:13.380 --> 00:38:16.050 between temperature and air pollution levels,

663 00:38:16.050 --> 00:38:20.790 the short term exposures, and the impact on total mortality.

664 00:38:20.790 --> 00:38:22.320 You can see in the graph again

665 00:38:22.320 --> 00:38:25.020 that the majority of the cities contributing data

666 00:38:25.020 --> 00:38:27.093 come from US and Europe,

667 00:38:27.965 --> 00:38:29.580 and the difference at the top

668 00:38:29.580 --> 00:38:32.910 is the different levels of average temperature,

669 00:38:32.910 --> 00:38:36.813 and lower is the different levels of ozone, for example.

670 00:38:38.010 --> 00:38:41.430 To graphically quickly show you the results,

671 00:38:41.430 --> 00:38:44.490 these are the results from North, Central,

672 00:38:44.490 --> 00:38:45.690 and South America.

673 00:38:45.690 --> 00:38:48.090 So we have the PM 2.5,

674 00:38:48.090 --> 00:38:51.570 let's focus on the main central figure.

675 00:38:51.570 --> 00:38:54.030 It's PM 2.5 effects,

676 00:38:54.030 --> 00:38:57.870 or total mortality by levels of pollutant.

677 00:38:57.870 --> 00:39:01.380 So you can see again a steady trend,

678 00:39:01.380 --> 00:39:03.960 both for Canada, for example, and US,

679 00:39:03.960 --> 00:39:07.600 although this may not be statistically different

680 00:39:08.700 --> 00:39:09.840 between them.

681 00:39:09.840 --> 00:39:11.790 As temperature levels increased,

682 00:39:11.790 --> 00:39:16.590 the effect of PM 2.5 on mortality increases.

683 00:39:16.590 --> 00:39:20.250 This is not the pattern that is observed in Mexico

684 00:39:20.250 --> 00:39:24.810 or other areas of Latin America,

685 00:39:24.810 --> 00:39:27.540 but of course, you may consider that the number of cities

686 00:39:27.540 --> 00:39:32.540 contributing data differs by the country shown here.

687 00:39:33.210 --> 00:39:36.420 The same patterns, pretty much,

688 00:39:36.420 --> 00:39:39.990 was observed in the majority of the European cities.

689 00:39:39.990 --> 00:39:43.500 You can see here for PM 2.5 in Northern Europe,

690 00:39:43.500 --> 00:39:47.283 we have increasing terms in Norway,

691 00:39:48.840 --> 00:39:52.410 but not a consistent pattern for other countries.

692 00:39:52.410 --> 00:39:54.570 There was a increasing trend

693 00:39:54.570 --> 00:39:59.570 also for (indistinct) particles, and the levels,

694 00:39:59.610 --> 00:40:03.750 the effect of ozone depending on temperature levels

695 00:40:03.750 --> 00:40:07.443 did not seem to vary in the European cities.

696 00:40:10.500 --> 00:40:13.740 To give you an idea in numbers,

697 00:40:13.740 --> 00:40:17.940 these are the overall global estimates

698 00:40:17.940 --> 00:40:20.100 of the health effects of the pollutants

699 00:40:20.100 --> 00:40:22.740 depending on the level of air pollution.

700 00:40:22.740 --> 00:40:25.710 So globally, we may see increasing effects,

701 00:40:25.710 --> 00:40:30.710 either of PM 10, PM 2.5, or ozone effects

702 00:40:31.260 --> 00:40:32.760 on total mortality.

703 00:40:32.760 --> 00:40:35.400 Of course, because these are global estimates

704 00:40:35.400 --> 00:40:37.500 of the air pollution health effects,

705 00:40:37.500 --> 00:40:42.500 there is large (indistinct) in this kind of meta-analysis.

706 00:40:42.720 --> 00:40:45.360 As I mentioned earlier, indirect pathway

707 00:40:45.360 --> 00:40:48.780 between climate change and air pollution health effects

708 00:40:48.780 --> 00:40:51.360 comes from wildfires,

709 00:40:51.360 --> 00:40:54.790 and here is one study we had been doing

710 00:40:55.680 --> 00:40:58.560 about 20 years ago that studied the impact

711 00:40:58.560 --> 00:41:00.960 of forest fires on mortality,

712 00:41:00.960 --> 00:41:04.650 and how this could be associated from particulate matter.

713 00:41:04.650 --> 00:41:09.650 This is a dot diagram trying to figure out the pathway

714 00:41:10.920 --> 00:41:13.320 that this may have affected health.

715 00:41:13.320 --> 00:41:15.810 So we may have direct effect,

716 00:41:15.810 --> 00:41:18.540 direct death as an effect of forest fire,

717 00:41:18.540 --> 00:41:22.200 or we may have an indirect death

718 00:41:22.200 --> 00:41:25.680 through increases in particulate matter levels,

719 00:41:25.680 --> 00:41:28.230 or even through increases in temperature,

720 00:41:28.230 --> 00:41:32.520 because locally, the temperature levels also increase

721 00:41:32.520 --> 00:41:33.660 due to wildfire.

722 00:41:33.660 --> 00:41:38.343 So this may affect our health outcomes in multiple pathways.

723 00:41:39.540 --> 00:41:43.140 This figure shows the severity and occurrence

724 00:41:43.140 --> 00:41:47.347 of forest fires in the Southern Europe from 2003 to 2011.

725 00:41:48.540 --> 00:41:52.620 Of course, there was variability depending on the country,

726 00:41:52.620 --> 00:41:57.620 but in general, we saw that there was not much difference

727 00:42:00.150 --> 00:42:05.150 on the effects of particles depending on forest fire days

728 00:42:05.160 --> 00:42:08.640 or non forest fire days.

729 00:42:08.640 --> 00:42:10.830 On smoke free days, for example,

730 00:42:10.830 --> 00:42:15.830 there was a 0.5% increase in total mortality,

731 00:42:16.500 --> 00:42:19.680 and on wildfire affected days,

732 00:42:19.680 --> 00:42:22.500 the increase in mortality was almost double,

733 00:42:22.500 --> 00:42:25.710 but it was not statistically significant,

734 00:42:25.710 --> 00:42:27.837 and it was a very wide (indistinct).

735 00:42:28.860 --> 00:42:30.930 But that's why I mentioned that,

736 00:42:30.930 --> 00:42:32.850 although the results may not be

737 00:42:32.850 --> 00:42:36.990 statistically significantly different between them,

738 00:42:36.990 --> 00:42:41.990 because we have much fewer count of wildfire affected days,

739 00:42:42.900 --> 00:42:45.900 we can see that in most of the cases,

740 00:42:45.900 --> 00:42:49.263 the impact is greater in wildfire affected days.

741 00:42:50.640 --> 00:42:52.020 I mentioned briefly

742 00:42:52.020 --> 00:42:56.130 that what solid fuel emits is black carbon,

743 00:42:56.130 --> 00:42:58.230 and I mentioned that black carbon

744 00:42:58.230 --> 00:43:00.180 is one of the most toxic components

745 00:43:00.180 --> 00:43:03.240 of ambient particulate matter.

746 00:43:03.240 --> 00:43:05.040 Black carbon health effects

747 00:43:05.040 --> 00:43:06.840 have been increasingly been studied.

748 00:43:06.840 --> 00:43:10.650 This is again from the same consortium that I showed you

749 00:43:10.650 --> 00:43:13.170 the paper before, from forest fires,

750 00:43:13.170 --> 00:43:17.553 that we assessed the effects of black carbon on mortality.

751 00:43:18.630 --> 00:43:23.040 And we can see that it had high health effects,

752 00:43:23.040 --> 00:43:25.410 either on the same day of exposure,

753 00:43:25.410 --> 00:43:29.550 or up to an average of three days before the events,

754 00:43:29.550 --> 00:43:31.710 both in Athens and Barcelona.

755 00:43:31.710 --> 00:43:34.290 And the effects of black carbon were much higher

756 00:43:34.290 --> 00:43:39.270 than the ones that usually are observed and attributed

757 00:43:39.270 --> 00:43:40.563 to particulate matter.

758 00:43:41.850 --> 00:43:46.850 This is another study on wildfire sourced PM 2.5,

759 00:43:49.290 --> 00:43:51.540 also coming from the same consortium

760 00:43:51.540 --> 00:43:54.548 studying short term health effects

761 00:43:54.548 --> 00:43:56.697 of air pollutants and temperature effects.

762 00:43:56.697 --> 00:44:00.600 And this study focused exactly on the health effects

763 00:44:00.600 --> 00:44:05.600 from PM 2.5 that was emitted from wildfire.

764 00:44:05.910 --> 00:44:07.887 And you can see again, the figure,

765 00:44:07.887 --> 00:44:12.887 the number of city that contributed data, sorry,

766 00:44:13.740 --> 00:44:18.740 and the level of wildfire related PM 2.5 by city.

767 00:44:21.180 --> 00:44:25.680 They assessed the effect of wildfire PM 2.5,

768 00:44:25.680 --> 00:44:29.220 either on the same day, or up to six days before,

769 00:44:29.220 --> 00:44:30.860 or the red...

770 00:44:32.550 --> 00:44:34.920 The red point on the figure on the left

771 00:44:34.920 --> 00:44:37.650 stands for the three days moving average

772 00:44:37.650 --> 00:44:42.650 of the exposure to wildfire related PM 2.5.

773 00:44:43.410 --> 00:44:46.710 So in all cases, we see very high effects

774 00:44:46.710 --> 00:44:49.920 up to three days after the exposure,

775 00:44:49.920 --> 00:44:52.800 or on the average of the same

776 00:44:52.800 --> 00:44:55.413 and two days prior to the event.

777 00:44:56.250 --> 00:45:01.080 Particularly for US, there was a 0.3% increase

778 00:45:01.080 --> 00:45:05.310 in total mortality associated with PM 2.5

779 00:45:05.310 --> 00:45:08.640 that could be attributed to wildfires.

780 00:45:08.640 --> 00:45:11.640 And this was the same percent increase

781 00:45:11.640 --> 00:45:15.450 attributed also for cardiovascular or respiratory mortality.

782 00:45:15.450 --> 00:45:18.180 Again, the magnitude on the effects

783 00:45:18.180 --> 00:45:21.963 depending on the location, as you may expect, differs.

784 00:45:23.550 --> 00:45:26.840 I also mentioned briefly that we expect an increase

785 00:45:26.840 --> 00:45:31.260 in the frequency duration of desert dust episodes,

786 00:45:31.260 --> 00:45:34.140 and we know also that desert dust

787 00:45:34.140 --> 00:45:38.777 may have impacts on health, and here is again a paper

788 00:45:40.830 --> 00:45:44.650 investigating the impact of desert dust

789 00:45:46.625 --> 00:45:49.457 on daily mortality in southern Europe.

790 00:45:50.520 --> 00:45:51.960 And you can see,

791 00:45:51.960 --> 00:45:56.960 because particles from desert dust are of larger diameter,

792 00:45:57.870 --> 00:46:01.080 we assessed here the health effects of PM 10,

793 00:46:01.080 --> 00:46:03.480 that are larger, as I mentioned in the beginning,

794 00:46:03.480 --> 00:46:07.800 compared to PM 2.5, and whether this could be attributed

795 00:46:07.800 --> 00:46:09.840 to non desert dust sources,

796 00:46:09.840 --> 00:46:14.010 or desert sources, excuse me.

797 00:46:14.010 --> 00:46:17.730 So in total, for example, for all cause mortality,

798 00:46:17.730 --> 00:46:21.390 an increase in PM 10 was associated

799 00:46:21.390 --> 00:46:25.290 with a 0.5% increase in total mortality.

800 00:46:25.290 --> 00:46:30.290 This was a bit higher, 0.55, for non desert PM 10,

801 00:46:31.530 --> 00:46:36.530 and PM 10 originating from desert dust

802 00:46:37.710 --> 00:46:41.520 had even higher effect on total mortality,

803 00:46:41.520 --> 00:46:44.400 and pattern was pretty much the same

804 00:46:44.400 --> 00:46:46.830 when we assessed cardiovascular mortality,

805 00:46:46.830 --> 00:46:48.300 respiratory mortality,

806 00:46:48.300 --> 00:46:51.573 and also there was an impact on hospital admissions.

807 00:46:52.800 --> 00:46:56.820 Just to close, and apologies for taking all the time.

808 00:46:56.820 --> 00:47:00.330 We had a major event in Athens last year

809 00:47:00.330 --> 00:47:02.580 that you may not be aware of,

810 00:47:02.580 --> 00:47:07.580 but for our twisted mind as scientists was very intriguing,

811 00:47:09.090 --> 00:47:12.060 because we have a very intense heat wave

812 00:47:12.060 --> 00:47:15.510 that lasted more than three weeks,

813 00:47:15.510 --> 00:47:18.030 and after two weeks of heatwave,

814 00:47:18.030 --> 00:47:21.720 also a major wildfire started

815 00:47:21.720 --> 00:47:24.270 in the northern suburbs of Athens.

816 00:47:24.270 --> 00:47:28.500 So we are in the process of studying this

817 00:47:28.500 --> 00:47:32.250 on mortality in the general population of Athens.

818 00:47:32.250 --> 00:47:36.300 The graph shows the excess number of deaths,

819 00:47:36.300 --> 00:47:41.300 and you can see the counts in daily mean temperature

820 00:47:42.480 --> 00:47:46.560 in the previous years, compared to the period

821 00:47:46.560 --> 00:47:48.870 that the heat wave and the desert

822 00:47:48.870 --> 00:47:52.560 and the wildfire started in Athens,

823 00:47:52.560 --> 00:47:57.560 and also the average number of deaths in previous years,

824 00:47:57.870 --> 00:48:00.810 and the excess numbers of deaths during this episode,

825 00:48:00.810 --> 00:48:02.930 that we can see higher increases, of course,

826 00:48:02.930 --> 00:48:05.490 in temperature and excess deaths.

827 00:48:05.490 --> 00:48:08.730 And briefly, some very premature results.

828 00:48:08.730 --> 00:48:12.600 When we try to associate the increase on mortality,

829 00:48:12.600 --> 00:48:14.010 on daily mortality

830 00:48:14.010 --> 00:48:17.430 attributed to this very intense heat wave,

831 00:48:17.430 --> 00:48:20.580 this accounted for about 20% increase.

832 00:48:20.580 --> 00:48:21.870 This is a huge increase.

833 00:48:21.870 --> 00:48:26.870 If we consider, for example, that high temperature levels

834 00:48:27.600 --> 00:48:32.600 account for about four to 5% increase in daily mortality,

835 00:48:33.102 --> 00:48:36.330 20% increase in daily mortality due to a heat wave

836 00:48:36.330 --> 00:48:39.630 is a very severe public health issue.

837 00:48:39.630 --> 00:48:43.590 And this even reached 70% increase in daily mortality

838 00:48:43.590 --> 00:48:45.660 when this intense heat wave

839 00:48:45.660 --> 00:48:50.660 was combined with a wildfire that lasted about a week

840 00:48:50.880 --> 00:48:52.533 in the outskirts of the city.

841 00:48:53.940 --> 00:48:57.780 So to conclude, and thank you for your attention,

842 00:48:57.780 --> 00:49:00.720 there seems to be synergistic and interactive effects

843 00:49:00.720 --> 00:49:03.030 between climate change variables,

844 00:49:03.030 --> 00:49:05.670 such as temperature and air pollution.

845 00:49:05.670 --> 00:49:08.086 There is heterogeneity on the effects,

846 00:49:08.086 --> 00:49:10.680 depending on the location we are studying,

847 00:49:10.680 --> 00:49:12.600 but this may be also attributed

848 00:49:12.600 --> 00:49:17.250 to a large variety of factors, also socioeconomic factors,

849 00:49:17.250 --> 00:49:20.910 the percent of aging of the population,

850 00:49:20.910 --> 00:49:23.550 and other demographic characteristics.

851 00:49:23.550 --> 00:49:26.760 There is a call for further research interactions

852 00:49:26.760 --> 00:49:28.950 between parameters of air pollution

853 00:49:28.950 --> 00:49:30.810 and climate change events,

854 00:49:30.810 --> 00:49:33.780 but also on the assessment of the cumulative effects

855 00:49:33.780 --> 00:49:37.620 of all these environmental factors.

856 00:49:37.620 --> 00:49:38.970 And there's also a need

857 00:49:38.970 --> 00:49:42.090 to address more complex future scenarios,

858 00:49:42.090 --> 00:49:46.380 accounting for reduction on tailpipe emissions

859 00:49:46.380 --> 00:49:49.950 due to the electrification of the fleet,

860 00:49:49.950 --> 00:49:51.660 as I mentioned earlier.

861 00:49:51.660 --> 00:49:55.080 But this is also expected to account for an increase

862 00:49:55.080 --> 00:49:59.643 in non tailpipe emissions, due to tire wear and brake wear.

863 00:50:00.750 --> 00:50:05.670 And we need to push through policy decisions

864 00:50:05.670 --> 00:50:08.880 to develop solutions that will effectively tackle

865 00:50:08.880 --> 00:50:12.900 both climate change and air pollution levels,

866 00:50:12.900 --> 00:50:14.920 because these seem to be

867 00:50:18.554 --> 00:50:20.827 undividedly interchanged between them.

868 00:50:22.410 --> 00:50:24.810 So thank you very much for your attention,

869 00:50:24.810 --> 00:50:27.510 and I would particularly like to thank my team

870 00:50:27.510 --> 00:50:29.010 in the University of Athens,

871 00:50:29.010 --> 00:50:33.810 and also the consortium of the EXHAUSTION research program

872 00:50:33.810 --> 00:50:35.880 at (indistinct) in Europe.

873 00:50:35.880 --> 00:50:39.330 And I will be happy to discuss any questions,

874 00:50:39.330 --> 00:50:44.313 either today, or in person in about two weeks time.

875 00:50:46.230 --> 00:50:47.213 <v Professor Chen>Thank you.</v>