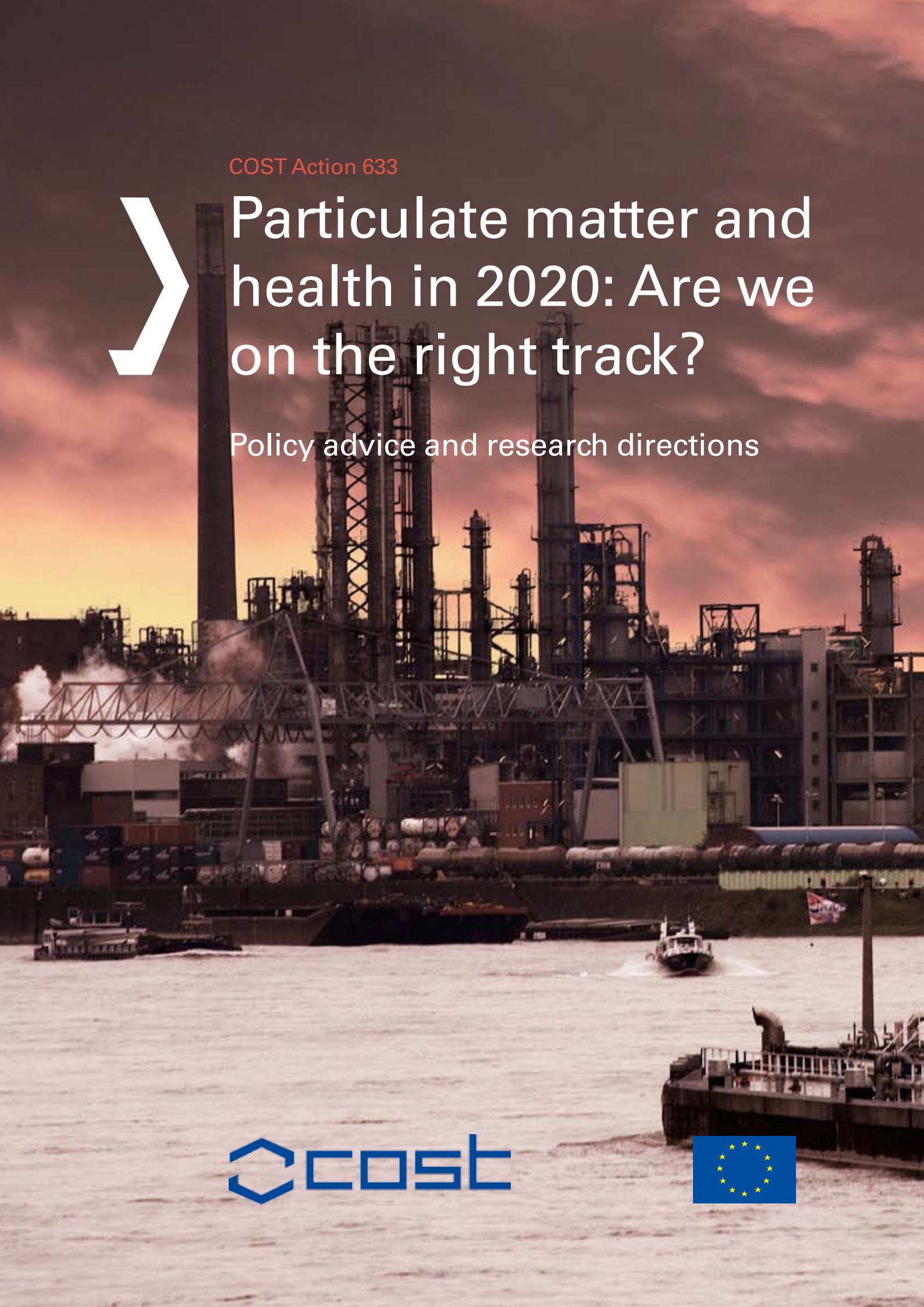
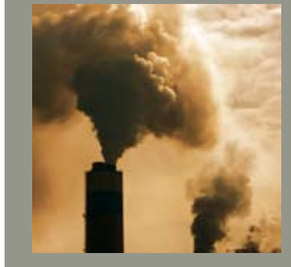


COST Action 633

Particulate matter and health in 2020: Are we on the right track?

Policy advice and research directions

cost



Introduction

The revised EU air quality directive is now on track after numerous legislative and implementation efforts during the last few years. During the revision and discussion of this directive, several important issues especially related to particulate matter (PM) were taken up within the Clean Air for Europe (CAFE) Programme. Not all issues could be tackled in the revision process due to lack of scientific data. There are still major uncertainties and serious gaps in the present scientific knowledge that need handling by the next evaluation of the air quality directive in 2013. The changing PM pollution in Europe leads to further information needs by stakeholders, policy-makers and decision-makers. Much more emphasis should be put on the role of PM in health impact and climate change. It is widely accepted that PM is an indicator for a complex mixture of air pollutants and that PM is highly correlated to many gaseous pollution components. Yet, for targeted abatement strategies, new information is needed on the most toxic emissions and conditions. Given that PM includes harmless as well as harmful material, indicators that are better linked with biological effects were discussed for their additional use in standard setting. The COST action 633 brought together experts in the field of particle measurements, transformation of atmospheric aerosols, exposure, epidemiology, toxicology and modeling of aerosol sources, atmospheric processing, and other fields and provided a genuinely interdisciplinary platform to formulate questions, discuss possible answers and identify research that needs to be performed in the near future and beyond.

In a two-day meeting (Brussels, March 13 – 14, 2008) COST action 633 members gathered information and provided guidance for dealing with current heterogeneities and future changes in Europe-wide PM levels and characteristics, as well as the health implications due to air pollution and climate change mitigation policies.

What is the problem of the changing source patterns and emission characteristics?

With regard to modelling and source apportionment

- Good emission inventory data and source profiles are lacking for some sources (e.g. modern tail pipe PM emissions from vehicles, (re)suspended dust, forest fire smoke PM, residential wood burning PM, etc.).
- Separation between natural and anthropogenic contributions is difficult for some constituents (e.g. OC, PM number).
- Vehicle emissions change fast due to new emission limits and technologies (e.g. PM traps, biofuels, metals from catalysts etc.). Therefore, it is difficult to be up-to-date in source modelling.
- Sources are misclassified due to changed source representation by some tracers (e.g. As: coal combustion vs. natural gas or liquid fuels, NaCl: sea salt vs. road de-icing salt, $MgCl_2$: road de-icing (reduces dust resuspension) vs. other (mineral) sources).
- The contributions to PM from chemical transformations of emissions need to be reconsidered on the basis of new scientific information on atmospheric processes.

For assessing short-term and long-term health effects

- PM compositions will change rapidly (e.g. with increased use of solid and liquid biofuels for heating and transport), but we lack even the basic toxicological data needed for risk assessment.
- PM source - health effect relationships cannot be reliably assessed without updating and extending the source apportionment information (see above).

What is the value of alternative indicators for PM mass?

Several alternative indicators for PM mass (PM10, PM2.5) have been put forward in the scientific community: Black Smoke, elemental carbon, particle number and an oxidative stress index. The basic idea is that they are better at representing specific (health relevant) sources and/or have a closer connection to health effects, thereby provide a better opportunity to detect causality between certain air pollution types and sources and health effects.

Are we able to monitor these alternative indicators?

Yes, though there are major differences in measurement techniques used by the scientists and no European standardized methods. In addition, setting up standards takes currently too long.

Which parameters could be alternative indicators?

- Black Smoke has been and is still used in EU countries as an air quality indicator.
- Elemental carbon is preferred to Black Smoke. The only advantages of Black Smoke are the long historical datasets and low cost measurements.
- Ultrafine PM (or the number of particles per volume) in different microenvironments have differences in chemical composition. Despite concerns on the health risks related to ultrafines, little information is published.
- Particle numbers may not be alternative for PM mass, but a good additional parameter.
- The oxidative stress index (oxidative potential) of PM should be further investigated due to its potential to give valuable additional information about the health risks. No conclusions can be drawn yet about the likelihood to become a standard metric for legal limit values and administrative monitoring of PM pollution.
- An indicator of PM surface reactivity may be a good general measure for health risks but like the oxidative potential and particle number concentration, needs further validation.

When is an indicator a good indicator?

- A good indicator has direct connection to health effects and helps identifying contributions of different PM sources and/or harmful components in ambient air.
- PM1 (ultrafines) would be better than PM2.5 for a fine PM pollution measure. Larger size particles (>1 or >2.5µm) should be monitored in parallel to PM1 (or PM2.5) since these fractions are also linked to (albeit different) types of health effects.

Where should we go from here in European PM Research?

- Establishment of PM super centres with high-standard harmonized methodology to increase the quality of European-wide aerosol data (the regions do differ from each other in PM composition and health risks!) to be used to identify source contributions to and the oxidative potential of PM as well as the associated health effects.
- The interdisciplinary approach of the field achieved in COST 633 should be incorporated into integrated PM science with harmonised methodologies, i.e. combine the expertise from air quality, modelling and health effects including modelling of the whole chain of events.
- PM has a dual role in health effects as well as in climate change, which means that also the measurement techniques used in these two, currently separate scientific areas should be harmonised with each other.

Key messages

Why do we regulate PM? To reduce the associated health effects!

Current challenge

- Changing source patterns and emission characteristics are likely to change the dose-response relationship. PM-mass is only a proxy for the PM-characteristics that cause the effects. What is the consequence for risk assessment and standard setting?
- We need (a) metric(s) that is (are) directly linked to the causative pathway leading to health effects. The current mass-based approach brings the focus on the most mass-intensive sources and to mass causal factor related to health endpoints. Mass per se may not be the most relevant metric to describe the concentration- dose-response relationships and may even neglect other specific health effects caused by PM i.e. particle number concentrations. This fraction is poorly correlated with PM mass (in time and space), whereas scientists have serious concerns about the impact of these small and numerous particles. If these particle numbers are stronger correlated to or have different impact on health effects, this would mean inefficient use of resources available for abatement strategies if the focus is only on PM mass.

What PM-properties cause the health effects? What are the indicators?

- We currently have several candidate characteristics, namely Black Smoke/elemental and organic carbon, particle number and surface, and an oxidative stress index.
- The oxidative stress paradigm offers a good explanation for the known health effects of ambient PM and thus favours an oxidative stress index.
- Several tests are currently available to determine an oxidative stress index, but these tests need further evaluations and harmonization.

Where do we go from here?

We need a validated new metric for the next legal cycle. Therefore, the following validation steps are needed:

- more mechanistic research on the toxicological aspects of PM;
- large epidemiological studies involving several old and new metrics in parallel with good time-space resolution linked with detailed information on emission sources including toxic potency of the whole (chemical) mixture;
- studies to understand how sources and emission patterns contribute to the novel metrics and indices;
- development / improvement to have reliable and easy-to-use (robust) measurement methods and devices;
- use well validated exposure models to propose new guidelines, based on scenarios, for the next generation of policy orientations.

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