The Future of Air Quality Management

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Abstract

This final chapter considers how air quality management may change in the future. Air quality monitoring will likely expand to measure more pollutants in denser networks in more communities, and may refocus on pollutant issues that negatively impact the vulnerable population. Satellite technology will be increasingly applied to meteorology and air pollution monitoring, especially to provide data in remote areas such as Canada's North. Monitoring equipment may become smaller, be less expensive to build and operate, and be less power demanding. Real-time air quality forecasting will undoubtedly become more accurate as meteorological modeling and air quality models improve and refocus on weather patterns conducive to degraded air quality. Emissions data from industry and transportation may become more widely available in near real time to enable these models to produce more accurate and useful predictions. Research into the impacts of ultrafine particles and pollutant mixtures on health, should pave the way for improved methods of reducing health risk. Increased awareness at both the domestic and international level of the health risks related to air pollution from industry, particularly resource-based industries, will likely lead to increased pressure to reduce industrial emissions. Remarkable reductions in on-road transportation emissions will likely continue through better post-combustion treatments and the inclusion of better pollutant control systems in off-road vehicles. Electric and hydrogen vehicles will eventually increase their share of the market, resulting in lower emissions within urban communities. National air quality management programs will increasingly mandate reductions in air pollutants and their health impacts for the whole country, including Northern regions. Canada's close binational relationship with the U.S. will continue and expand north. Air pollution management will make more effective use of the many new approaches to communications from new approaches to formulating air quality messages to new ways of linking air quality data to personal devices to enable individual actions in response to real time air quality.

Keywords

Future air quality management · Alternate fuels · Air quality monitors · Evolving technology · Pollutant trends · The North

20.1 Introduction

This chapter assesses what developments could occur in air quality management in the future based on information from authors of earlier chapters and from other health, air quality and meteorological experts.

As noted by Jeff Brook in Chap. 3 in this book on the State of Canada's air quality, current pollutant concentra-

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tions in populated areas are considerably lower than they were when the Department of Environment was created in the 1970s, Though Canada has been successful in reducing its burden of air pollution, new emission sources will likely develop and existing sources will expand. The latter includes the rapid development of one of the world's great petroleum deposits—the oil sands and heavy oil resources in Alberta. This massive activity will continue to release large amounts of greenhouse gases, nitrogen oxides (NO_x) and sulphur dioxide (SO_2), the latter two contributing to acid precipitation and air pollution (Dyer et al. 2013).

In this milieu, it is not known whether we can accomplish further significant reductions in the impacts of pollutants on health. Will challenges still persist in areas in Canada where ozone (O_3), fine particulate ($PM_{2.5}$) and toxics continue to exceed standards? Will the public recognize significant improvements in visual air quality? Climate change may also play an important role in air quality issues as shifts in global patterns of temperature, precipitation, wind and atmospheric stagnation continue to occur.

20.2 Monitoring Air Quality in the Future

Since air pollution impacts health, and by extension the health care system, it will certainly remain a public policy issue of concern. An increasingly skeptical public needs assurance that pollutant concentrations adhere to standards and that any potential impacts are documented. It therefore follows that the routine monitoring and reporting of air pollution concentrations will likely continue to be important in the future, particularly in areas where large numbers of people are exposed to air quality that affects their health.

20.2.1 Improving Existing Monitoring

Canadian air quality monitoring networks that report data to the national air quality database now operate 318 air monitoring stations in 217 communities, using over 800 instruments. These include continuous analyzers for SO_2, CO, NO_2, O_3, and fine particulate matter. Toxic substances such as polycyclic aromatic hydrocarbons (PAH), dioxins and furans, and heavy metals such as arsenic, lead, and mercury are also measured at many of these stations (Environment Canada 2012). The techniques and systems to measure these ambient air pollutants have improved significantly in recent decades and will likely continue to do so in the future. The numbers of both monitors and monitored pollutants will also likely continue to rise as the population increases and as the natural resource sector expands into previously uncharted territory. The following recent moves by Environment Canada should help ensure that monitoring will provide ever-improving air quality data to the public in the future.

- A program has been implemented to ensure that monitoring instruments are properly maintained and replaced when an instrument has reached its end of life. This has reduced the average age of NAPS instruments from over 15 years old to 5 years old over the past decade.
- Existing continuous $PM_{2.5}$ instruments are being converted to U.S. Class III Federal Equivalent Method (FEM) instruments. (See Chap. 3 for information on FEM monitors.)
- Federal, provincial, and municipal data logging and data reporting systems are being modernized to allow timelier reporting of data, and to improve the quality of real time data.
- The existing $PM_{2.5}$ chemical speciation network is now using updated samplers and measurement programs for VOCs, a significant improvement over the previous network.
- The laboratories and analytical equipment used to carry out detailed chemical analyses, such as VOC and $PM_{2.5}$ speciation, have been expanded (Environment Canada 2012).

20.2.2 Emerging Monitoring Issues

Future air quality monitoring systems in Canada may refocus on a number of emerging issues.

- Air quality programs may increase their focus on long-range sources of pollution, specifically on sources from

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Asia. This may occur as emission rates increase in Asia, causing increased transport across the Pacific and ultimately higher ambient concentrations in North America. Concurrently, local emission reduction efforts may become more successful and relatively less important.

- Mobile monitoring could increase and become more focused on health impacts at "hot spots" near emission sources such as busy roads and in heavily industrialized areas. By being portable, these instruments need only remain in one location long enough to sufficiently characterize air quality before moving to another areas where other health risks exist. These mobile monitors would complement the information from fixed sites further away from sources.
- Satellite-based remote sensing of air pollutants may improve the amount and accuracy of air quality data collected, particularly if surface-based observations are routinely integrated with satellite-derived measurements. This would extend the spatial and temporal coverage of current monitoring networks.
- Improvements in technology should also be able to transfer air quality data from satellites and other sensors to systems more rapidly and efficiently, allowing air quality forecasting systems to better manipulate and make use of those data (see Sect. 20.9).
- As the climate changes, emissions, atmospheric chemical reaction rates, temperature and atmospheric patterns such as stability and precipitation regimes may also change. Measuring and documenting these changes in the future will provide valuable information for air quality managers.
- Monitoring for precursors to ozone, ultrafine particles and other particulate matter could increase in the future. This will provide better support for air quality forecasting models, improvements in emission control strategies and programs to reduce health risk.
- Future governments from around the world may pool resources to increase market incentives to support the commercialization of advanced methods of air quality monitoring.
- The boundary layer may be monitored more intensively and routinely in the future to ascertain its depth, dynamics, structure, pollutant concentration profiles, and temperature profile. (Committee on Environment and Natural Resources 2010).

20.2.3 Evolution of Air Quality Monitors

Emerging technology promises more widespread monitoring of air quality. For example, electrochemical sensors are beginning to offer the ability to monitor multiple pollutants and meteorological parameters in a single unit at a fraction of the cost of traditional 'active' monitoring. Nanotechnology is further increasing the reliability and precision of electrochemical sensors, which can now measure multiple pollutants at concentrations as low as one part per billion in a small, single unit.

Smart phone technology and wireless infrastructure are providing platforms for new air quality sensors that are becoming smaller, less costly and able to monitor other variables such as temperature. New monitoring units are also increasingly power stingy, loosening the logistical constraints of more traditional devices. Using these monitored data, mobile applications ("apps") are able to automatically handle two-way data transmission, data compilation and analysis, and share the resulting information with the public. By providing real-time data transmitted through cellular or satellite channels, communities and governments alike will increasingly be able to monitor air pollution hotspots, background sites or entire airsheds. The increased affordability and ease of use of these new technologies may revolutionize air quality monitoring as we know it (see Sect. 20.9). Deploying simple inexpensive and multifunctional sensors for routine monitoring and field studies can provide greater data density to better understand the spatial and temporal variations of pollutants and human exposure. In the future, widespread use of sensor networks for multiple pollutants may significantly improve our understanding of linkages between air pollutants and adverse health effects and provide insight on the cumulative impacts of multiple pollutants (White et al. 2012).

These new tools need to first prove themselves in Canada's challenging environments. As this is done, monitoring systems should be increasingly able to expand without significant increases in resources. This would be a boon to air quality management processes such as air quality assessment, reporting and pollution control.

20.3 Future Developments in Air Quality Forecasting

Currently, Environment Canada provides two-day forecasts of pollutant concentrations and the Air Quality Health Index to 74 communities across Canada, primarily through its Weatheroffice website (weather.gc.ca). However, as roles of governments change, some specialized air quality forecasts are now being produced at the provincial level. An example is the BlueSky wildfire smoke forecasting system now operating in British Columbia. In the future, additional specialized forecast products and related health advice could be developed at the local level using air quality models to focus on specific communities with unique air quality problems, such as smoke accumulation in deep valleys.

As discussed in Chap. 4, regional air quality can be impaired from the long-range transport of air pollutants.

However, as shown in Chap. 5, air quality is also often impaired from local emissions during stable, stagnant conditions, when meteorological dynamics are weak, allowing pollutants to accumulate near the surface. In these situations, local variations in cloud cover, solar intensity, temperature and wind can quickly lead to changes in small scale circulations, resulting in variations in local mixing depth and other local atmospheric conditions. Pollutant concentrations can vary quickly as a result of the development of these small-scale circulations, (Zhang et al. 2012), which in turn can be influenced by synoptic scale events. Unfortunately, current meteorological models are not designed to represent air pollution episodes that have very weak dynamical forcing (Baklanov et al. 2002). On top of this, errors in conventional numerical weather prediction models can propagate rapidly into air quality dispersion models and cause large errors in pollutant concentration forecasts (e.g. Hess et al. 2004).

Future air quality forecasting systems will therefore become more accurate only when models improve their predictions of small-scale meteorological events that are important for air quality. These include improved predictions of local circulations such as land-sea breezes and topographically-induced circulations, as well as physical processes such as turbulence, boundary layer depth, cloudiness, etc. This will require modelling of meteorology on fine scales (about 1 km grid resolution), particularly in heavily populated regions (Zhang et al. 2012). This will in turn require improved parameterization of elements such as stagnation, turbulence, deep convection, low clouds and nocturnal transport that are critical to determining pollutant concentrations (Zhang et al. 2012). Progress is already being made on this task. For example, during the 2010 Winter Olympic and Paralympic Games in Vancouver, Environment Canada produced meteorological forecasts at 1 km resolution over southwestern British Columbia (Mailhot et al. 2010).

Future air quality forecasting systems may also provide forecasts for longer periods, perhaps up to two weeks, to match some current atmospheric models such as the Global Forecast System, instead of the present one or two days. More and better pollutant data should also become available for input into air quality forecasting systems. This includes data from improved satellite measurements of near-surface concentrations and vertical profiles of many important chemical species (e.g., McLinden et al. 2012). Emission estimates should also improve when they account for variations in current weather conditions, since weather itself can affect emission rates (e.g., forest fire smoke, VOC emissions from agriculture and nitrogen oxide from motor vehicles). When current emissions from large industrial sources are available in real time and online for use by air quality models, air quality forecasts will also be more accurate and therefore useful (Zhang et al. 2012). In the future, the suite of pollutants being forecast may also expand to include selected toxic chemicals and allergens such as specific pollens.

20.4 Future Progress in Identifying Health Impacts

Future research should fill important gaps in our understanding of the impacts on health of air pollution, guiding policies to further reduce emissions, ambient concentrations and risks to health. As mentioned by Dave Stieb in Chap. 7 in this book, the health impact of mixtures of multiple pollutants is an important issue. Many sources, including traffic and other combustion processes, emit multiple pollutants that are comprised of hundreds of chemical species. As is the case with multiple drugs, health may be more dangerously affected by the synergistic action of multiple pollutants than the sum of their effects individually. Unfortunately, the public is exposed simultaneously to many pollutants whose concentrations are highly correlated with each other (Billionnet et al. 2012). This makes statistical linkages with health impacts difficult. Improved understanding of the relationships between pollutants and health will likely evolve to address this issue over time, particularly as our understanding of the biological and chemical mechanisms and the health impacts of these pollutant mixtures increases.

Future research is also likely to uncover more important information on the health risks of ultrafine particles (UFP), particles that are much smaller and more numerous than $PM_{2.5}$. Due to their ability to penetrate deep within the lung, UFPs may be a major concern for respiratory exposure and health. If warranted, there will likely be efforts to reduce exposure and related health risks. It may be more challenging, however, to reduce their concentrations, particularly indoors, since they appear to be ubiquitous and persistent. Health professionals could develop better warning systems that are more useful and targeted, particularly for those vulnerable to high concentrations of certain pollutants.

As Dave Stieb has noted in Chap. 7, studies of air pollution interventions have shown that reducing air pollution results in reduced health risks. This provides powerful support for the value of continuing to improve air quality. Future research will inevitably lead to further ways to reduce and even prevent pollution. This could also influence how we work, where we live and how we make personal decisions that affect our health. This will occur as research results find their way into policies to further reduce emissions from vehicles, industry and domestic heating. Health impacts will diminish as we plan to reduce traffic congestion and introduce wider setbacks from traffic for residential buildings, care facilities and schools. Health impacts will also moderate when individuals make more informed personal decisions to reduce their air pollution exposures and protect their health (see Sect. 20.9).

20.5 Industrial Emissions—Future Directions

Air quality management requires a good knowledge of current emissions from industrial sources, but acquiring these data is not always easy or prompt. In the future, various types of air quality management systems could obtain industrial emissions types and rates in real time. For large industrial emission sources, in-stack instruments can provide these data. For smaller sources, calculations could be made based on the real-time fuel consumed or the production rate. Perhaps improved methods for short-term forecasting of changing emissions will also be developed. Industrial emission inventories for any time period, facility or industrial area could also be calculated as needed. Future information and communications technology systems should be able to securely and rapidly transmit these data to where it is needed, including users such as air quality forecasters who could incorporate them into air quality models to produce more accurate and precise predictions. This would then allow health professionals to develop better warning systems that are more useful and targeted, particularly for those most vulnerable to high concentrations of certain pollutants.

The good news is that future emissions of unhealthy pollutants from industry are likely to diminish due to local and international pressure. If markets are threatened by public opinion, industry will be forced into greater action to restore consumer confidence and retain both a local and an international social license to operate. Emission reductions will likely be accomplished through cleaner industrial technology, including switching from burning coal or oil to cleaner fuels such as natural gas. A current example of this process is the international pressure on the perceived emissions from the industrial development of the Alberta oil sands.

In the future, emission *standards* should be able to be updated more frequently and reflected in more responsive and efficient permit systems. Permits should simultaneously become more effective and equitable while also being simple to implement. Environmental and health agencies will likely also push for more accurate and robust air quality models so that permits can be based on more reliable pollutant modelling scenarios. Real time air quality modelling could be also be part of the permit system in the future, allowing industrial emissions to be temporarily reduced in real-time if these models predict increased human exposure to unhealthy pollutants, particularly near schools and senior's homes where the population is more vulnerable to air pollution.

These and other approaches to future industrial emissions will help in building long term sustainability of businesses, particularly if shareholders and corporate executives take more of a multigenerational and global view.

20.6 The Future of Road Transportation and Air Quality Management

The subject of air emissions from transportation is an ongoing concern from an air quality and human health perspective as well as the significant contributions of the transportation sector to greenhouse gas emissions. Emissions from on-road vehicles are of particular concern from a human health perspective due the proximity of the emissions to the general population living in urban centres.

Impressive reductions in air pollutant emissions from on-road vehicle have been achieved in the past 25 years by the emission control technologies that have been mandated by increasingly strict regulations. While alternative fuels have played a role in the early reductions of air pollutant emissions, the more dramatic reductions currently being realized are due to aggressive after-treatment (i.e. post combustion) technologies. Even with the increasing travel demand, the future air pollution burden from on-road vehicles can be expected to continue decreasing, regardless of the fuel being used. Emission control technologies are also beginning to be implemented in the off-road, marine and rail sectors, albeit at a slower pace.

The overwhelming dependence of the transportation sector on petroleum as the source of primary energy is clearly an unsustainable trend in terms of the depletion of a non-renewable resource and the climate change effects. Electricity and hydrogen are the energy carriers that have the potential to include other sources of primary energy in the mix for transportation. Gasoline-electric hybrid vehicles, plug-in hybrid vehicles and all electric vehicles are already in the on-road vehicle fleet in North America and are poised to claim a gradually increasing share of the fleet. How quickly this change will occur is still up for debate.

The wide range of fuel economies that are achievable by on-road vehicles suggest that significant reductions in greenhouse gas emissions can be achieved by consumers' choices. However, even the relatively higher fuel prices in Canada do not appear to have a strong effect in this regard. Natural gas as a lower carbon intensity transportation fuel, or renewable biofuel, has the potential for modest reductions in the greenhouse gas emissions from the sector.

The developments in alternative vehicles and fuels are currently motivated primarily by greenhouse gas concerns, as well as the diminishing availability of conventional oil. However, in many cases there are co-benefits of lower emissions of criteria air contaminants that are concurrently realized since any pollutants emitted from internal combustion engines are emitted in much closer proximity to humans. Life-cycle analysis of alternative fuels and energy technologies should be employed in the future to quantify the associated upstream emissions, and regional air quality models should be used to analyze the effect of emissions associated with the production of the fuel. Only in this way can we expect to have an accurate picture of the effect of our multiple objectives and efforts on the air we breathe.

20.7 Canada's Developing North—Air Quality an Emerging Concern

Canada currently manages air quality across its southern border with the United States through the Canada/US Air Quality Agreement, which is described in Chap. 16. Of course we have a second border with the US, namely the Yukon/Alaska border. With the development of the oil sands as well as developments in Alaska and ultra-long range transport from Asia, we can expect that Northern people will identify air quality concerns, and, at present, there is no bi-national regulatory framework under which to discuss and manage these issues.

In 2008, the International Joint Commission's (IJC) International Air Quality Advisory Board (IAQAB) held a workshop in Anchorage to discuss transboundary air quality and in 2010 that workshop was followed up with one in Whitehorse. Reports from these workshops as well as the summary, "Report on Air Quality Issues related to the Northern Boundary Region between Canada and the United States" can be found on the IJC website (International Air Quality Advisory Board 2010, 2012).

Southern experience seems limited in applicability in the North because air quality concerns in the North are quite different from those in the South. The Inuit people have been exposed to a variety of chemicals (such as herbicides and pesticides), that were never used in the North, through long range transport from the South. It is expected that as Canada takes over the chair of the Arctic Council, for example, such issues will come forward into the international arena.

Alaska's Panhandle is volcanically active and one of the global Volcanic Ash Advisory Centres is located in Anchorage and run by the National Oceanographic and Atmospheric (NOAA). Volcanic activity with the gases released, can affect air traffic to the North, and, indeed, globally.

There are few roads in the North, but the few that are present can be the source of dust that may contain harmful particulates. Thus, air pollution sources in Alaska and probably the Yukon include road dust, resource development, diesel generators, and open burning of solid waste.

As the northern sea ice melts, ocean navigation is increasing rapidly. Eco-tourists are becoming more common, and with the collapse of winter ice roads, resupply of Northern communities is often done by sea. Marine air pollution is a possible emerging issue for some Northern communities. We should expect to see oil spill damage in the north as exploration and extraction increase. Conditions at northern spill locations will be much different than experienced in the Gulf of Mexico (for example).

To compound the difficulty of managing air quality in the North, there are few air quality monitors, especially on the Canadian side of the Alaskan border. Programs such as the Northern Contaminants Program (NCP) and the International Polar Year (IPY), both led by Aboriginal Affairs and Northern Development for Canada have laid a basis for understanding air quality issues in the North. Newer programs, emerging since devolution, such as the Nunavut General Monitoring Plan (NGMP 2013) and the Northwest Territories Cumulative Impacts Monitoring Program (CIMP) are beginning to establish the need for data, but it will be many years before scientists have the data required to be able to knowledgably advise jurisdictions on a science-based management approach. The Canadian High Arctic Research Station recently established in Cambridge Bay will evidently have environmental monitoring as one of its priorities when it starts up in 2017.

The advent of satellite programs such as RadarSat and the and the future Polar Communications and Weather (PCW) Program, can offer spatially dense data with rapid revisit rates. It will be important for the air quality management community to make use of these modern data to complement ground based measurements in remote Northern areas.

As we've seen throughout this book, monitoring and modeling together make up credible systems for supporting air quality management. We've seen that current models focus on transboundary transport of pollutants, examine urban and global scales and forecast weather. These forecasts predict the movement of volcanic ash, surface pollutants and upper level ozone and solar radiation and simulate movements of a number of pollutants from special sectors as well as smog, acid deposition and air toxics. At this time, there is not the same level of confidence in northern model results as there is in the south for such applications as weather. prediction and ecosystem management for a variety of reasons including lack of monitored data. This is an important future issue for Canada.

As development occurs in the North it will be expected that Canadian innovation will continue. Air quality management systems will be called on to extend their reach over new vast areas which are sparsely populated but expected to house major industrial facilities in some of the most sensitive ecologies on earth.

20.8 Communicating Air Quality Issues: From Imagination to Implementation

Raising the awareness of air quality issues among individuals will continue to be an important component of air quality management in the future. In 2011 Sharon Stevens, the author of Chap. 19, predicted it would not be long before personal health data intersected with air pollution data to give people personalized advice on air quality and their health. Soon after, in June 2012, the US Environmental Protection Agency and the National Institutes of Health created an air pollution sensor challenge called *My Air*, *My Health*—www.epa.gov/research/challenges. The challenge was created to encourage development of portable devices that would gather and integrate health and air quality data. Individuals and teams submitted designs for sensors that can be easily worn or carried and link airborne pollutants and a person's health measurements such as heart rate and breathing.

There are already a multitude of examples of clever, creative and collaborative efforts to advance awareness of air quality. The select few provided below offer a glimpse into the future of air quality outreach and communication. Many examples will have been imagined and put into practice by the time the ink on this page has dried—or is downloaded.

Flash Mobs, Die In's And School Strikes Children have gathered in Haifa, Israel, wearing charcoal-blackened ties and masks, to urge adult voters to think about air pollution issues when they vote. Environmentalists in Hong Kong have organized "Lights Out Hong Kong" as a way of sending a message to their government about the city's rapidly worsening air pollution. More than 15,000 students in southern Kuwait staged a "stay home from school strike" to protest against air pollution. And a London-based organization called Climate Rush held a mass 'die in' in Soho Square to raise awareness of the health impacts of air pollution in that urban city.

These grass roots events in today's world are an important part of a continuum of global outreach that is increasing awareness about the quality of air we share. What will tomorrow's world bring?

New Sectors in the Sandbox As more people stand up for the air we share, more governments, organizations and sectors of our economy will find ways to align with the issue of air quality. Even the fashion industry is contributing to awareness of, and potential solutions, related to air quality.

Dress for Success In an effort to show reduced environmental impact, the fashion industry has introduced a fabric they claim reverses the environmental impact of air pollution. The "Purifying Dress", developed by the Centre for Sustainable Fashion at the London College of Fashion and the University of Sheffield, claims to use a textile which can reverse the impact of air pollution. Through the power of a photo-catalyst, the fabric claims to break down air borne pollutants (Storey 2012). A professor of physical chemistry at Sheffield University has teamed up with a popular fashion designer to develop a laundry additive they claim will stick to the surface fibers of cloths, and neutralize nitrogen oxide.

Fig. 20.1 NYU student's wearable technology T-shirt

Fig. 20.2 Non-Sign II. (Image by Ian Gill courtesy of Lead Pencil Studio)

New York University grad students Sue Ngo and Nien Lam, as part of a class in Wearable Technologies, used thermo-chromic fabric to design a shirt featuring a graphic of lungs which change colours based on exposure to CO2 (Fig. 20.1). Using tiny CO2 detectors, the microcontroller sends electrical currents through the fabric and as the temperature of the fabric changes, so does the colour of the graphic on the colour of the shirt.

Building on Benefits What looks like a billboard, an outdoor marketing format most commonly used to market burgers, cars and beer, is making a silent statement about environment and air quality. This sculpture (Fig. 20.2) sits at the U.S.–Canada border crossing between British Columbia

Fig. 20.3 Semiamoo Sky Garden. (Image credit: Green Over Grey Living Walls and Design)

and Washington State. It was designed as a permanent billboard advertising, well, nothing. Not really. It is designed to promote the clean air of Blaine, Washington. Called Non-Sign II, a Seattle art and architecture firm, Lead Pencil Studio, was commissioned to produce it by the U.S. federal government.

Coca-Cola and the World Wildlife Fund unveiled a 60-by-60 foot billboard in the Philippines that is covered in Fukien tea plants to absorb CO_2 and alleviate air pollution within its proximate area.

In many major metropolitan areas, living walls are helping improve air quality. Designed and installed by Green Over Grey Living Walls and Design, the exterior face of the Semiamoo Sky Garden in Surrey, British Columbia was transformed into the largest outdoor vertical garden in North America. It has 10,000 individual plants representing 120 unique species (Fig. 20.3).

These are but two examples of the convergence of interest and awareness in air quality, urban architecture and outdoor art.

Maximizing Mobile to Promote Air Quality The use of Smart phone technology has exploded and will only continue to evolve at break neck speed. Marketing and communication innovators have been quick to combine web and mobile technology. Near Field Communication (NFC) is enabling mobile users to simply tap their devise against anything that has an interactive tag (from magazine ad to bus stop shelter) and go from awareness to action—either getting their local real time air quality report or sharing an air quality message with friends or family.

Learning by Doing The most effective way to attract attention and change behavior for the better is to give people a way to interact with your topic—and if possible, make it interesting and fun. Here are two examples of how this is being achieved:

Throughout the world's largest cities, interactive billboards offer increased opportunity to attract attention and engagement.

In **Ca**nada, the Agency of Health and Social Services of Quebec City (Agence de la santé et des services sociaux de la Capitale-Nationale), through their creative agency lg2, used interactive billboards to raise interest in careers in public health. A bus shelter poster features a person in a hospital bed with a "flat" electrocardiogram indicating no heartbeat. When passers-by push their hands on the image of the patient's heart, the electronic electrocardiogram beats, reinforcing the rewards of a career in public health (Fig. 20.4).

Referred to as a Fun Theory (www.thefuntheory.com), this Volkswagen initiative proposes that something as simple as fun is the easiest way to change people's behaviour for the better. The Piano Stairs Project demonstrates how turning public staircases into life-size piano keys, complete with

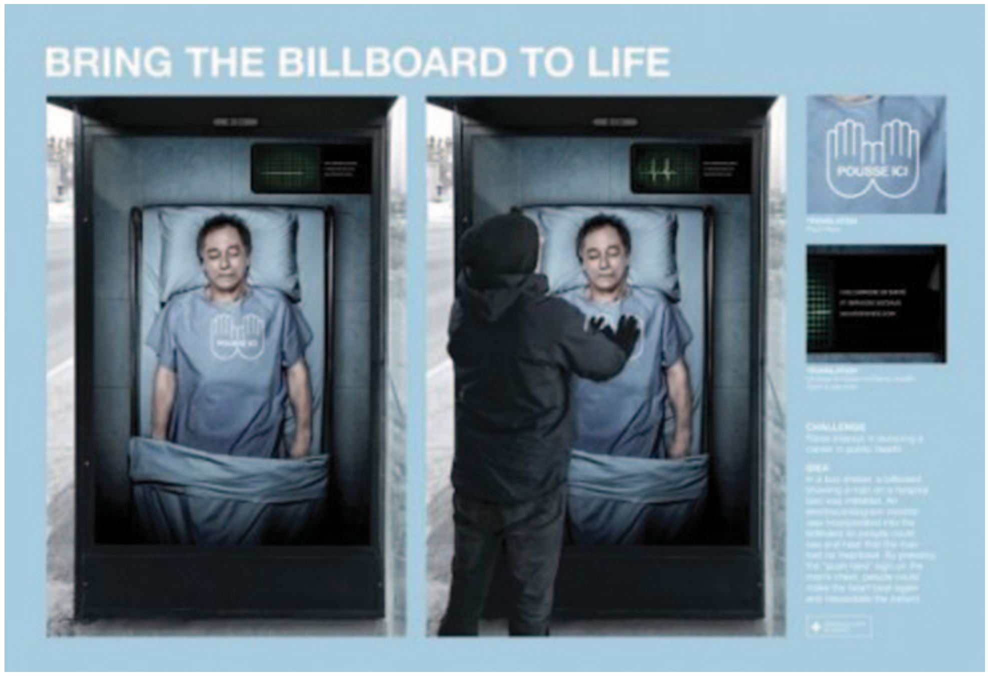

Fig. 20.4 Electrocardiogram interactive billboard

the appropriate audio reinforcement for each stair, or in this case key, encourages and rewards the choice to take the stairs instead of the escalator.

Consider the possibilities when technology and creativity come together to engage people on the topic of health and environment and prompt them to change their behavior for the better.

It's an exciting time to be creating social marketing programs about air quality and health. The more air quality becomes part of our social dialogue, around both the boardroom table and the kitchen table, and is integrated into our community planning, our expression of art and culture, and our economic growth, the more the collective consciousness will grow. And with that will come an increase in individual behaviors to protect oneself from the risks of air pollution, and to be better stewards of the air we share.

20.9 Canada's Air Quality Management System—Improving Future Air Quality

An Air Quality Management System (AQMS) has recently been developed to guide future air quality management in Canada. It is the product of collaboration among the federal, provincial and territorial governments and stakeholders and promises to be a comprehensive approach to improving and protecting air quality. The Canadian Council of Ministers of the Environment (CCME), the primary minister-led intergovernmental forum for collective action on environmental issues of national and international concern, has the responsibility for refining and implementing the AQMS (CCME 2012).

Federal, provincial and territorial governments all have roles and responsibilities in the implementation of the new Air Quality Management System as it is rolled out over the next several years. The AQMS has several key components which will have a significant impact on future air quality management in Canada. These are:

- New *Canadian Ambient Air Quality Standards* (CAAQS), benchmarks for outdoor air quality management across Canada
- Industrial emission requirements that set a base level of performance for major industries
- A framework for air zone air management within provinces and territories that enables action tailored to specific sources of air emissions in a given geographical area
- Regional airsheds that facilitate coordinated action where air pollution crosses a border
- Improved intergovernmental collaboration to reduce emissions from the transportation sector

The CAAQS will replace the existing Canada-wide Standards by strengthening standards for fine particulate matter ($PM_{2.5}$), ground-level ozone (O_3), nitrogen dioxide (NO_2) and sulphur dioxide (SO_2). Air quality management will be guided by an Air Zone Management Framework to ensure proactive measures are taken to protect and improve air quality in accordance with the principles of keeping clean areas clean and continuous improvement. Air zones will be a place-based approach to manage local air quality. They are to be both geographical regions as well as arenas for air quality management. The provinces and territories will delineate and manage air zones within their boundaries. The goal in all air zones will be to drive continuous improvements in air quality and to prevent the CAAQS from being exceeded. As in the past, the AQMS is expected to be based on the latest science. It will be challenging to reflect the things we now know (and the things we don't) especially about the impacts of pollutants on human health.

The AQMS has created six large, regional airsheds together covering all of Canada to coordinate efforts to reduce transboundary air pollution flows and report on regional air quality. However, it is unclear how the role of these AQMS airsheds will differ from the existing inter-jurisdictional air quality mechanisms. The AQMS airsheds should not be confused with the relatively small airsheds described in Chap. 17 on "Airshed Planning". The smaller airsheds were created in the past in British Columbia as an approach to managing local air quality in urban areas or narrow valleys, primarily to manage local emissions, the main contributor to poor air quality in these communities.

Base-level Industrial Emission Requirements (BLIERs) are quantitative or qualitative emissions requirements proposed under the AQMS for new and existing major industrial sectors and some equipment types. These requirements are based on what leading jurisdictions around the world are requiring of industry in "attainment areas," but adjusted for Canadian circumstances. The BLIERs are focused on nitrogen oxides (NO_x), sulphur dioxide (SO_2), volatile organic compounds (VOCs), and particulate matter (PM). BLIERs are intended to ensure that all significant industrial sources in Canada, regardless of where facilities are located, meet a required base-level of performance.

Emissions from mobile sources (transportation and small engines) are a major source of air pollution in many parts of the country, especially urban areas. However, there are multiple jurisdictions responsible for managing both these emissions and the resultant human exposure to harmful pollutants. Under the AQMS, governments at all levels will need to work together to ensure that emissions of pollutants, and the related human exposure, will continue to decrease in the future.

Monitoring and public reporting are critical to transparency, accountability and the effective implementation of the AQMS in the future. Provinces and territories, with assistance from the federal government, will be responsible for monitoring in the air zones and reporting to the general public in their jurisdictions on air quality and the measures taken to implement the AQMS (CCME 2012).

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