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The Sustainable Development Council Invitation and Response Document: Clean Air-Clear Choices

Will High Air Pollution Alert Days provide an efficient path to health protection?

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Background

The Air Quality Objective Concern Group has submitted separately a comprehensive set of comments on the Council for Sustainable Development's (CSD) three proposals. Here we address in more detail the proposal for High Air Pollution alert days (HAP alerts) made by the CSD in its public consultation.

Any appraisal of this proposal needs to focus on its *validity* and *utility* and these concepts need to be disclosed and explained to potential respondents before any informed forced choices or comparisons can be made, or would have any value for decision makers. The fundamental problem is that the definition of the HAP needs to be based on *health outcomes* which in turn requires the adoption of evidence-based criteria for harm reduction which can be derived from the best science currently available. The government asserts that we are not yet in a position to adopt current science based air standards in Hong Kong and this will remain a major rate limiting factor in air quality control for at least two more years.

The proposal to create an alert system for high air pollution days (HAPs) is based on the assumption that exposures to air pollutants can be significantly reduced and bad health outcomes avoided. There is no strong empirical evidence available from any studies to show that modification of usual activities of daily living (ADL) will make a major difference to the harm caused to population health by air pollution at the uniformly high levels generally experienced in Hong Kong.

The loss of visibility and our horizon over 20 years is the most visible evidence of our poor air quality. This trend (Figure 1) is also the curve for an epidemic of heart and lung disease in the HKSAR. It is a reminder than a large proportion of the complex gases and chemical particulates (comprising highly penetrating nano-sized material which does not settle, creates a pollutant "blanket" which simply cannot be avoided if the air is breathed.

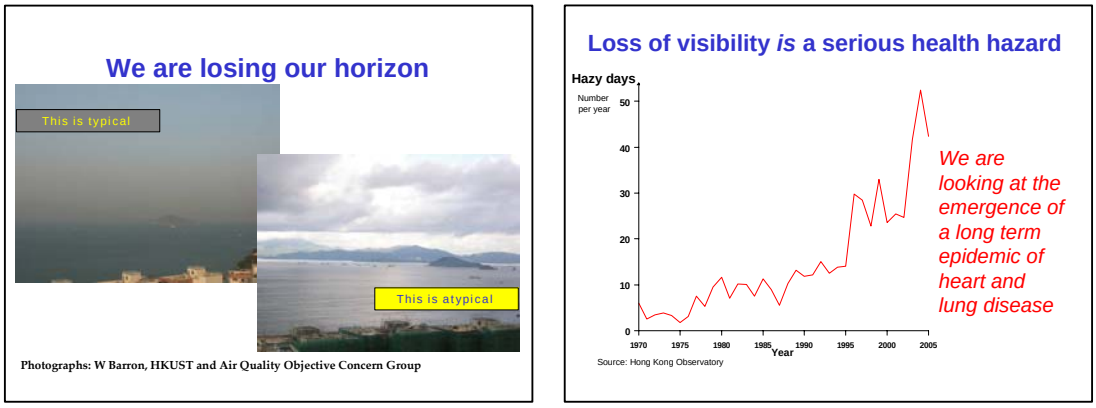


Figure 1: Poor visibility in Hong Kong is directly related to trends and episodes in air pollution. Loss of visibility is also a direct measure of illness and deaths caused by air pollution

What is the possible significance of HAP alert days?

The primary objective of a strategy and special interventions to improve air quality should be health protection, and all sectors of the community will expect any approach to be demonstrably evidence-based and cost-effective. Although it is mainly the current trends in loss of visibility which have driven arguments for urgent pollution abatement measures, we need to remember that it is the unseen and silent injuries caused by the *average* annual

levels of pollutants which are responsible for most of the burden of pollution related illness and deaths in the HKSAR. The very high pollution days will certainly make an additional contribution to the illness experience of many people, but they will be a relative minority of all days which are hazardous for health. Furthermore we cannot assume that we can do much to avoid the risks of the very high pollutant days.

It is important to remember that apart from the acute health effects which lead to increased daily doctor visits, hospital admissions and premature deaths, we should be deeply concerned about the long term impact on the growth and development of children's lungs. This is the site of a potentially irreversible injury at the most formative stage of a young person's development. It would not be prevented by calling occasional HAP alert days.[1]

Figure 2: Children are among the groups most sensitive to air pollutions. Damage to young growing lungs may be permanent and have lifelong effects on respiratory health and life expectancy.

One recent newspaper headline about the Council's public consultation told us that *"Now, it's up to you"*.[2] At this stage we would like to pose the question as to why it should be up to the general public to determine and decide how and when a major epidemic of disease (affecting heart, lungs and blood vessels and the lifelong health experience of children) should be prevented? We believe that the solutions are manifestly obvious and need to be applied through coordinated government action at the highest level and on an intersectoral basis.

There are important social and ethical issues to be considered here because the HAP alert proposal carries with it the implied promise of benefit and is likely to raise expectations that personal commitment, lifestyle change and probably inconvenience and privation will be rewarded with better health protection. This may not be true.

We need timely and effective interventions

There is no question that the only real hope for a *timely* and *effective* improvement in regional air quality will come from legislation and mandatory comprehensive interventions on *emissions* in all sectors, in a way which actually reduces the pollutant *concentrations* of the air we breathe. The first place this must happen for protection of the Hong Kong population is within the boundaries of the HKSAR.

From a public health viewpoint we suggest that the battle against pollution is currently being lost in terms of the daily threat to health and longer term environmental degradation. We have previously pointed to the avoidable community costs of pollution resulting from direct costs of health care needs and lost productivity. There needs to be clear recognition of the external costs of air pollution and a focus on approaches which will *reduce* it, rather than additional costly actions which will not do so.

Air quality standards are key to all interventions

The daily and annual average levels of all pollutants in Hong Kong are well above the guidelines agreed by the World Health Organization in 2005 and promulgated in a global promotion in 2006. A member of the HKSAR government Environmental Protection Department attended and contributed to the final WHO review meeting in Bonn in October 2005, so the government would have been well acquainted with the detailed evidence considered by the WHO Working Group on Air Quality Guidelines. The review was steered by experts in epidemiology, toxicology, air quality exposure assessment, air quality management and public policy. It is unquestionably a high quality state-of-the-art review.

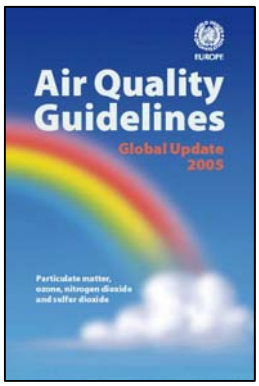


Figure 3: The World Health Organization Air Quality Guidelines (AQG) provide the best interpretation and synthesis of the current global evidence on health effects of air pollution. The guidelines are based on a precautionary approach to health protection.

Nevertheless the Hong Kong government believes it does not have sufficient evidence or guidance to implement new air quality standards or comprehensive strategies with explicit timelines to achieve abatement of the current high levels of pollution. The government's own review did not begin until mid 2007 and will not report until end 2008. Any meaningful action beyond that point will take a further indeterminate period. This delay needs to be viewed in terms of the unaddressed avoidable short term effects on illness and premature deaths, huge external costs to all sectors of the community and permanent long term damage to generations of young children and adolescents. The adoption and use of meaningful criteria for air quality would be central to the establishment of any HAP alert system.

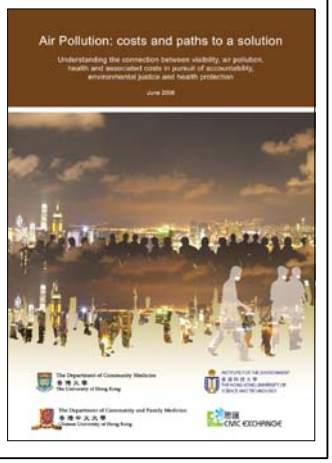
The community burden of the costs of air pollution

We need to continue to translate the excess risks of breathing dirty air into monetary values and measures of quality of life in an attempt to drive policies on the environment. It is now clear that simply calculating the large burden of disease – for example in terms of chest symptoms, hospital admissions and deaths – has not made any material difference to the government's approach.

Figure 4: The current position of both government and vested interests in the business sector is to ignore the external costs of pollution including the burden of illness across the whole community. We need to move to an evidence-based assessment of the impact of pollution on health which includes measures of quality of life impacts on the Hong Kong population.

We need to be able to translate excess risks of air pollution and effects of mitigation measures into monetary values and measures of utility in an attempt to drive policy

June 2006



We introduced the issue of external costs together with clear options for urgent action in our June 2006 report from the Air Quality Objective Concern Group.[3,4] The *preventable fraction* of the illnesses and premature deaths which could be achieved by reducing Hong Kong's air pollution is very large indeed. For example a reduction of our average annual pollutant levels, as measured at general monitoring stations,

down to the levels of the WHO guidelines, would avoid nearly 7 million doctor visits, over 60,000 hospital bed-days and up to 1600 deaths each year. The attributable *direct* cost of health care and lost productivity is about $2 billion per annum. About 50% of the population live within 100 metres of busy roadways. If we rate the health impact and costs using road-side pollution the benefits of mitigation are much greater. A question relevant to the HAP alert proposal is therefore, what difference will HAP alerts make to the community burden of disease and costs.

The CSD has claimed that we do not know what the public responses are to questions about *willingness to pay* for cleaner air, to prevent illness or deaths attributable to pollution. We would argue that this not true. There are now several sources of data which indicate the general scale of values which the public places on their preferences related to health protection from pollution. We have specifically reported on the intangible costs of pollution from our surveys on willingness-to-pay, to avoid a day of respiratory symptoms such as cough, a hospital admission for heart or lung problems and a premature death, all caused by breathing pollutants. The value of this is around $20 billion each year. The government's response to our report was muted or frankly negative and dismissive. The then acting director of the Environmental Protection Department, referring to our estimate of the overall economic burden of pollution *"…noted that the health care expenditure attributable to air pollution was indirect…"*.[5] Again this isn't true, but it also shows how both government and vested interests may place a very different value on the health threat caused by pollution compared with the lay public. Whether HAP alerts would work for health benefit or not we can expect that there will be many different viewpoints on their value.

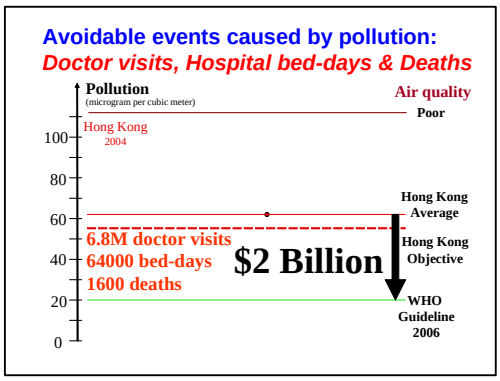


Figure 5: The reduction in doctor visits for health problems caused by pollution, hospital admissions for serious acute and chronic disease. The estimates for reduction in morbidity and mortality through air quality improvement do not yet include many bad health outcomes, such as the effects on the unborn foetus and long term effects on child health. The estimates are also conservative in that they are based on general monitoring station levels. It is possible that the health impacts are greater on those who live and work near busy roadways, estimated to be about 50% of the population. There is no evidence of a safe threshold for air pollutants and the upper limits of the WHO guidelines should not be regarded as safe.

The preventable fraction of illness and death is not simply a medical statistic but an issue of social justice and inequity for Hong Kong.

What is the value of the questions posed by the SDC questionnaire?

We would certainly agree that there is scope for further good quality surveys of public perceptions of the risks of air pollution and the monetary value of the penalties we pay. However we are disappointed with the structure and content of the SDC questionnaire. The questions posed in the survey are leading and tendentious. We do not think that they will give any indication of the uncertainty associated with a respondent's understanding of the issues or their choice of response. This is important because many questions, which are represented simplistically, are highly technical in nature or associated with other complex issues to such an extent that they either cannot be answered or are implausible as potential solutions to the hazard of air pollution.

Two key examples of poorly thought out questions would be:

Q8 *"How long before a high air pollution alert day should a notice be issued?*
Q12 *"Should we require employers to allow staff … with respiratory or heart disease to work from home?"*

We discuss these issues in later sections of this paper.

Our June 2006 report was a very conservative estimate of the burden of disease and costs, based on the best available local scientific evidence. The question therefore arises as to what the government will do with any pleas from the public for immediate and radical action to mitigate daily pollutant exposures which are likely to arise in this consultation – and have already been expressed for several years. Government reactions to public views submitted in other public health consultations have been the subject of concern and criticism. A clearer exposition of how responses from the public will be handled would create greater transparency and clarify the potential usefulness of the whole exercise.

Principles of efficient health care programmes

So bearing in mind that the principal force of morbidity and mortality is probably the *average* annual exposure to air pollution, what impact would HAP alert days make on the burden of disease and community costs?

Ideally in an *efficient* preventive health strategy, for example a screening test, we need to be able to identify the *maximum amount of risk* in the *smallest number of people.*

If we relate this to air pollution alerts we need to try and *maximize population health gains* by intervening *in the smallest number of days* each year.

There are two main problems here. First Hong Kong's levels of pollution for most of the year are generally uniformly high in terms of health risks throughout the year. It follows that any reduction in harm and benefit to health achieved by any single alert will be very low, in comparison to the overall risk. In order to have a chance of making a large difference we would have to call multiple HAP alerts across the year. We also need to remember that the pollutant threshold level for health protection (for example as indicated by WHO guidelines) is very low compared with Hong Kong's average levels.

We need cost-effectiveness affordability curves to assess the proposed HAP alert system. Put simply, we are talking about the three 'A's:

- Achievability
- Acceptability
- Affordability

Can we reliably predict HAP days?

The CSDC questionnaire asks the question

"How long before a high air pollution alert day should a notice be issued?"

This is a potentially unanswerable question in the sense that the prediction and timing of an alert will be driven by factors which are outside of anyone's control. Further discussion on this issue from environmental scientists would be useful.

Even assuming that possible benefit will result from a HAP alert, we need to recognize that the public, not least the business sector, will want reasonable precision in the announcement of an alert. Patterns of pollutant concentrations on very high pollution days show sharp divergent trends with the slope of the trend changing rapidly within an hour or two, often in the middle of the working day. These patterns are often complex. For example on September 15th – 16th 2007 there were about 7 different phases in a 24 hours period (Figure 6). On the day of the marathon, 4 March 2007, a major change in the level of pollutant concentrations actually occurred during the running events.

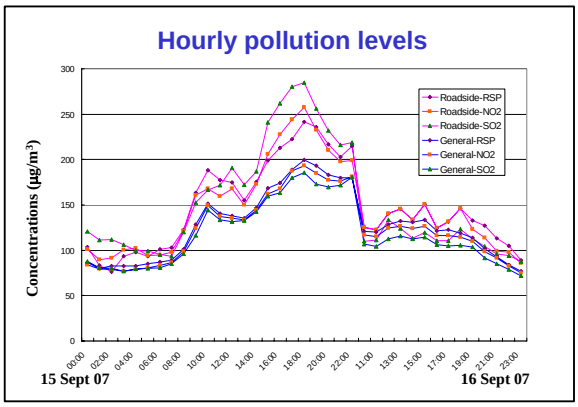


Figure 6: Typical patterns of pollutions at both general roadside monitoring stations often show sharp divergence from apparently stable levels occurring within an hour or two. Note that in this example both general and roadside monitoring station levels are high at 100μg/m³, rising to over 250μg/m³.

The background conditions and factors which lead to pollution alerts in other countries, especially for single pollutants such as an ozone alert in Phoenix, Arizona, are quite different from those which generate intense plumes of mixed pollutants in Hong Kong.

While there is no doubt that several criteria and general decision rules are available to facilitate the forecast of pollution levels it is extremely doubtful that any system can be calibrated so that it reliably and efficiently switches alerts on and off without incurring false positive and false negative actions.

What criteria should be used to trigger HAP alerts?

As things stand at present the HAP alert days would be signalled on the basis of an Air Pollution Index (API) calculated using the Hong Kong Air Quality Objective (HKAQO).

The API is determined not by the absolute risk associated with different concentrations and combinations of pollutants but by the HKAQO. The HKAQO is a single arbitrary cut-off value for pollutant concentrations which is now twenty years out of date as a scientific basis for health protection. It is scaled far too high with the effect that an API calculated on this basis will only trigger an alert when pollutants are well past harmful levels which cause both short and long term injury to heart and lungs. This problem does not just apply to particular very high pollution days; it applies to most days of the year in Hong Kong.

How can we estimate possible benefits of HAP alerts?

To illustrate the possible costs and benefits of HAP alerts in a valid and reliable way we will focus on the absolute concentrations of pollutants and consider what health related criteria we could use to trigger an alert. We have reasonably precise health risk estimates

for doctor consultations, hospital admissions and deaths associated with each 10µg/m^3 increase in particulates, nitrogen dioxide, sulphur dioxide and ozone. We can illustrate the possible costs and benefits of a HAP alert using selected cut-off points for pollutants as measured at both general and roadside monitoring stations. For example, the assumption might be that we could try to protect health by reducing population exposures to the upper 1%, or 10% of a pollutant such as respirable suspended particulates (RSP or PM_{10}). Alternatively we could use the WHO guidelines for 24 hour levels and estimate the total health benefits which might be gained if we reduced exposure to all pollutants by a certain proportion on alert days (Figure 7). We described a method for combining pollutant-health effects in our 2006 report.[4] Note that if we used the Hong Kong 24 hour HKAQO we would never have had an alert triggered by average general station levels in 2006 because the AQO is set so high.

We can map these chosen criteria for HAP alerts onto the daily levels of pollutants measured across the year. A graphic representation of this gives a rough visual guide to the number of HAP alerts which would be called using different criteria.

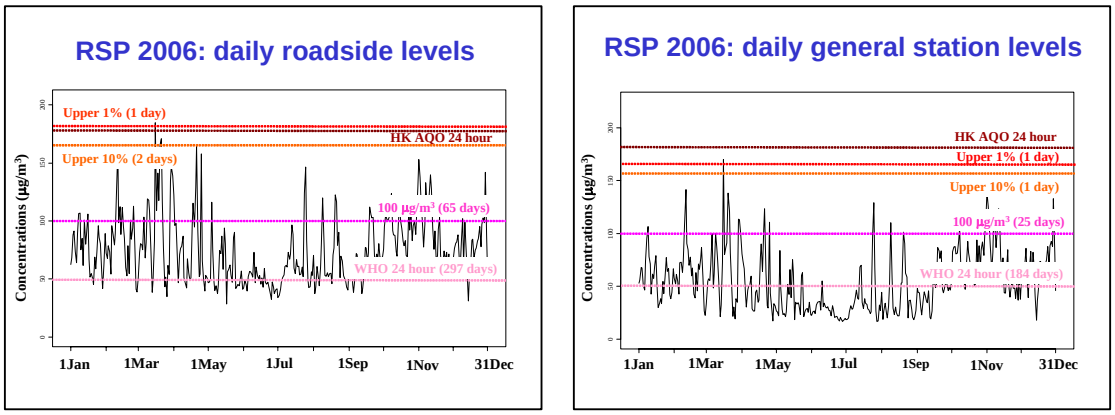


Figure 7: Respirable suspended particulates in 2006 measured at general and roadside monitoring stations, together with possible criteria for declaring a HAP alert and the number of days on which a HAP alert would be called using these criteria.

The number of HAP alerts called using the criteria we chose would range from 1 day up to 359 days. Clearly the low number would confer virtually no population health benefit on an annual basis, whereas the high number would be unacceptable on grounds of costs, social disruption and reputational damage to the image of Hong Kong.

The Council's proposal for HAP alerts include a "passive" approach, in which decisions are left to individuals and an "active" approach in which we assume that government may issue strong advisories or prescribe mandatory measures, presumably backed by legislation. Assume for the time being that HAP alerts could in some way lead to worthwhile gains in health protection by changing the public's usual behaviour and activities of daily living in a way which actually reduced exposures significantly. We then need to assess the values of cost of alerts and the benefits achieved.

What would a HAP alert cost?

The costs associated with mandatory measures during a HAP alert might be analogous to those incurred by a tropical storm ("typhoon") Number 8 signal. During such a period people are required or allowed to leave their workplace and go home, educational

institutions and many businesses close. The Labour Department has issued a detailed advisory directed to both employers and employees.[6] Employers are urged to *"make realistic and critical assessment of the essential staff requirements so that only the absolutely essential staff are required to report for duty under adverse weather conditions"* and *"when a typhoon signal No. 8 or above is issued employers should not require their employees to report for work for the sake of safety unless prior agreement to the contrary has been made"*.

In the past the issue of a Typhoon No. 8 has caused concern about its effect on the economy, especially because predicting the impact of an approaching storm is an uncertain business. Legislator, The Hon. James Tien in 2001[7] estimated that the value of a GDP working day, about $1 Billion, was at risk because of the impact on businesses which lost productivity and revenue but still had to pay salaries and costs. Another legislator The Hon. Fred Li estimated that 300,000 SMEs lost between $50,000 to $100,000 because of a Typhoon No. 8 signal.[7] Is it likely that many sectors of the community will be prepared to accept another general warning system, which will be difficult to apply, disrupt essential services and harm businesses and the wider image of Hong Kong as a tourism destination, finance centre and business hub?

SARS created another kind of alert which reduced mobility, emptied restaurants, other leisure venues, airports, transportation systems. We note that SARS changed the forecast for GDP growth from about +2% to -2% because of government and WHO advisories over a period of about 3 months.[8,9,10,11]

We believe that even if HAP alerts were cost-effective in health terms, the business sector, the government and the wider public would see them as a source of reputational damage to the HKSAR in the Asia Pacific region.

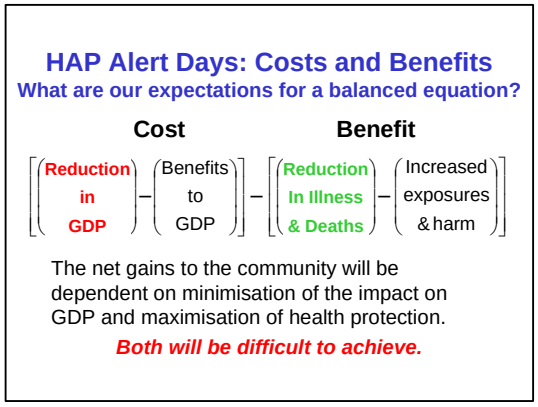


Figure 8: A basic assessment of net costs (cost minus benefits) from HAP alert days.

A basic cost-benefit equation, to indicate the net value of a HAP alert day, would include the cost incurred by reduced human activity; less any possible economic benefits of a HAP day arising from business (eg patronage of cinemas and restaurants) which would not otherwise have occurred. The benefits include all the potential reductions in direct health costs and lost productivity, which in turn may be reduced if increased harm results from actions taken during a HAP alert (Figure 8).

So what are our expectations for a balanced cost-benefit equation from a HAP alert?

What would the cost be in terms of the value of a GDP day?

- We have conservatively estimated the potential annual impact on GDP from repeated HAP alerts at only 0.5%, one quarter of the change in GDP forecast associated with the SARS impact.

- We optimistically rate the benefits of a HAP alert at about 25% reduction of the harm associated with the identified upper fraction of the daily pollution level which triggers the alert.
- At this stage, for simplicity, we have omitted any estimates of the relatively smaller values associated with economic benefits of a HAP alert or the additional harm to health which might result. They are unlikely to change the overall cost-benefit equation.

Table 1 shows that, in 2006, if we choose the upper 1%, or 10% of the annual pollutant range or, alternatively, cut-off values for RSP or NO_2 of 100µg/m^3, 75µg/m^3, or 50µg/m^3 (ie 100% above, 50% above, or the actual 2006 WHO 24 hour air quality guideline), then we would call HAP alerts on between 1 day and 226 days a year.

The most parsimonious option, using only the upper 1% of the annual pollutant distribution at general monitoring stations (Table 1; Scenario 1), leads to only 1 HAP alert day, costing $5 million but yielding only $30,000 in benefits, a cost benefit ratio of 167:1. If we select an alert cut-off of 100µg/m^3 benefits rise to $8 million but at a cost of $125 million and cost-benefit ratio of 16:1. Adopting the WHO 24 hour guideline would push benefits to about $100 million and the cost benefit ratio improves to almost 10:1, but the total cost is $1.1 billion.

Scenario 1:
RSP general level + NO_2 general level as the basis for an alert

(Million HK$)	HAP Criteria (Number of HAP alert days)				
	1% (1 days)	10% (2 days)	100 µg/m^3 (25 days)	75 µg/m^3 (81 days)	50 µg/m^3 (226 days)
Costs (0.5% GDP ~)	5	10	125	405	1,130
Benefits (25% exposure redn.)	0.03	0.36	8	30	99
Total = Costs – Benefits (Costs : Benefits)	4.97 (167:1)	9.64 (28:1)	117 (16:1)	375 (14:1)	1,031 (11:1)

Note:
Benefit = RSP + 0.41*NO2
Days = maximum number of exceedance days for RSP and NO_2

Scenario 2:
RSP roadside level + NO_2 roadside level as the basis for an alert

(Million HK$)	HAP Criteria (Number of HAP alert days)				
	1% (1 days)	10% (2 days)	100 µg/m^3 (163 days)	75 µg/m^3 (265 days)	50 µg/m^3 (359 days)
Costs (0.5% GDP ~)	5	10	815	1,325	1,795
Benefits (25% exposure redn.)	0.03	0.42	44	120	252
Total = Costs – Benefits (Costs : Benefits)	4.97 (167:1)	9.58 (24:1)	771 (19:1)	1,205 (11:1)	1,543 (7:1)

Table 1: Possible scenarios for estimating the costs and benefits of HAP alert days. Increasing the number of HAP alerts might possibly increase benefit, but at costs which will be very much higher than the value of these benefits.

If we rate costs and benefits by the much higher roadside levels it would be possible (under the doubtful assumption that significant benefits could be achieved) to improve the cost benefit ratio. But the costs would be prohibitive and the HKSAR would be paralyzed by pollution alerts (Table 1; Scenario 2).

What will be the economic impact and cost of a HAP alert?

It will depend on:

- perceived seriousness of the hazard
- frequency of alerts
- increased harm
- health benefits
- the sectors of the economy affected
- The cumulative effect on Hong Kong's image as a centre for business, finance, and tourism destination

Table 2: The economic impact of HAP alerts will depend on several factors in many different sectors.

It is worth noting again that the new WHO 24 hour guideline should not be exceeded on more than 3 days in a year. However applying this criterion in Hong Kong would result in alerts being called on 226 up to 359 days a year.

These data may be manipulated under a range of different assumptions, but because of Hong Kong's high pollution levels it is again highly

unlikely that the public, legislators or government will find that the intervention of a HAP alert day is value for money. Further detailed consideration should be given to the complex issues associated with evaluation of HAP alerts (Table 2).

Will an alert do more harm than good?

We have no empirical evidence applicable to Hong Kong that it is possible to reduce exposure (as measured by the "intake fraction" of pollutants) by issuing a general alert to the population. On the other hand exposures to ambient pollution are likely to be higher in those who take public transport as opposed to riding in the sealed environment of a private car. The vast majority take public transport but if an alert moved further significant numbers of people from private vehicles while air pollutants remain high then harm is likely to increase overall rather than decrease.

Reduction in the vehicle kilometers contributed by private cars may not make much difference to roadside pollutants. Beijing has discovered that arbitrary restrictions on cars do not lead to significant reductions in regional pollutants. Although we might expect some mitigation of roadside pollution, the same is likely to be true in the HKSAR where major emission sources are marine, commercial vehicles (especially those using mainland diesel) and power generation. HAP alerts are not designed to reduce these sources. In fact if HAP alerts tend to keep more people indoors power consumption may increase. Modern private cars contribute less pollution than outdated (pre-Euro, Euro I) commercial vehicles but have increased by 23% since 1995, while taxi numbers remain static. On the other hand heavy and medium goods vehicles have increased by 80% and 13% respectively, but the cleaner transportation provided by cargo trains has declined by 15%.

One suggestion is that exposures would be reduced by staying at home, including "working from home". Those who stay more at home might include infants and the elderly but their exposures are unlikely to be significantly reduced in a way which would protect their health.

A systematic study of the relationship between indoor and outdoor air pollutant concentrations will provide more information but, in general, indoor levels are determined by the outdoor environment. This is clearly shown by the example of measurements made at a Heng Fa Chuen 13th floor apartment on Friday 5th October (Figure 9). Closing windows and using extractors and air conditioners may reduce pollutants but the levels remain extremely high and a clear hazard to health. Particulates were measured with a portable meter, the *Sidepak* (TSI Inc.).

Changes in indoor respirable suspended particulates (PM_{10}) in the apartment during a 5 hour period with windows open and closed were compared with outdoor levels. Note that the scale in Figure 9(a) is in milligrams/cubic metre. The lowest pollutant level recorded with the windows closed is about 190µg/m^3 which is 10µg/m^3 above the 24 hour HKAQO and 140µg/m^3 above the WHO 24 hour guideline of 50µg/m^3.

We acknowledge the issues about comparability between hand-held types of particulate meter, such as the *Sidepak* (TSI Inc.), and the TEOM (Tapered Element Oscillating Microbalance) system used in the EPD fixed monitoring stations in Hong Kong. These

issues are highly technical and apply to the performance of both portable equipment and TEOM.* [12,13]

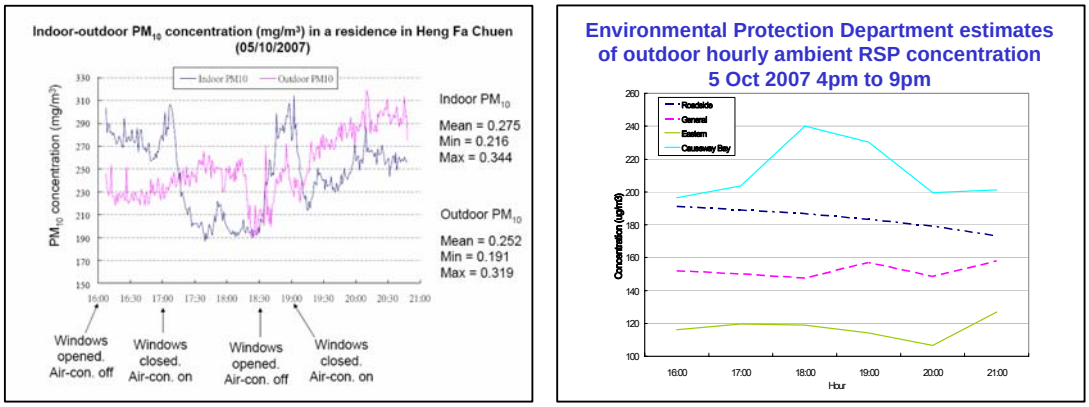


Figure 9: Outdoor and indoor RSP (PM10) levels tracked closely together in a Heng Fa Chuen apartment, when windows were open. Closing windows did not reduce RSP to safer levels. RSP levels reported by the Environmental Protection Department at Causeway Bay, show very high levels of particulates across the monitoring period 4pm to 9pm. Mean roadside levels (Causeway Bay, Central, Mongkok) were more or less stable, with a slight downward trend, between 190-180µg/m^3 across the period. Mean levels at general stations varied between 150-160µg/m^3 with a slight upward trend. Causeway Bay, the station with possibly the most relevance to the Heng Fa Chuen area, showed RSP ranging from 200µg up to 240µg/m^3. The Sidepak monitor estimate of outdoor RSP at 6pm was 250µg/m^3 compared with the EPD Causeway Bay level of 240µg/m^3.

In our single illustration of indoor levels we simply demonstrate that the portable meter recorded outdoor particulate levels of very similar magnitude to those recorded by the Environmental Protection Department during the same time period. The indoor levels tracked the outdoor levels very closely.

In these findings reflect the general relationship between indoor and outdoor pollutant levels, the conclusion must be that staying at home is unlikely to confer any worthwhile health benefit for the majority during a very high pollution episode. For the fortunate minority of workers who enjoy the advantages of a sophisticated air filtration system in their workplace, a day at home would probably be an extra hazard.

Who could *try* to benefit?

By "working at home", walking to work, taking public transport……..

Potential target groups	Possible consequences
• Civil servants:	Close public offices
• Children/teachers:	Close schools
• Health care staff:	Close clinics
• Retail trade:	Close shops
• Port activities:	Close terminals
• Taxi drivers Bus drivers Train drivers	Shutdown public transport
• Delivery services Van drivers Porters	Close wholesale industry

Table 3: Those who might benefit most by "working at home" are those least able to leave their worksites

The idea of "working from home" is an unrealistic proposition for the majority of workers. A list of common occupations clearly indicates that those at greatest risk of pollution related health effects, because of their disadvantaged socio-economic status would be least able to protect themselves even if staying off work did confer any benefit (Table 3). If any benefit did result from staying at home then those most likely to gain would probably be excluded from work this opportunity. Furthermore they may be penalised unless they were compensated for staying away from work and some of the

* There are reasons why portable meters may either under or overestimate inhalable particulate levels. The *Sidepak* is one of the instruments which may overestimate. However all portable monitors usually show good linearity, when measuring particles in the respirable range, compared with standard reference samplers. TEOM systems may underestimate levels of particles which are of relevance to health risk exposures because of loss of volatile and other fractions in the mix of particulates.

priority business activities of the HKSAR were disrupted as a result. There are important interactions between outdoor pollution exposures and life-style factors such as smoking,[14] exposures during exercise[15] and probably the nutritional value of diets. Investment in *effective* lifestyle modification programmes may be one beneficial approach to partial protection against pollution effects. However the issue of exercise is particularly difficult to address. In the 1998 Hong Kong lifestyle and mortality study those who took no exercise had the highest mortality risks[16] and when we examined the pollution effects those with the lowest and highest exercise levels had the highest pollution related mortality risks after adjustment for other health risks. Those who, by chance, calibrated their exercise to intermediate levels had lower risks of an exercise-pollution mortality interaction.[15] These findings relate to the lifestyles of adults 10 years before they died.

Can we reliably identify those at high risk?

The question as to whether employers should be required to allow employees with respiratory or heart disease to work from home raises many additional problems. The question is naïve in terms of the issues we have raised about levels of indoor air pollutants in domestic settings and the lack of opportunity for many workers to take their service jobs to their homes.

A major issue would be the identification of high risk groups in a way which is medically sound, ethical and protects privacy. People who are susceptible to pollution do not wear this label on their chest. For some the status of their cardiovascular risk factors is known, for others it is not. Some have established diagnoses and treatment, others do not. We know that pollution causes illness and premature death but those events occur in groups which are heterogeneous in terms of their past medical history. For everyone concerned this information is usually sensitive and often confidential. It is simply not feasible that a sophisticated, valid, privacy protected system could be implemented which classifies the entire working population in terms of its daily susceptibility to pollution.

Although those with severe chronic established medical problems would be eligible it is likely that any high risk labelling scheme would incur many false negatives and therefore be inefficient and inequitable.

Labelling individuals as being at high risk is likely to be stigmatizing, may lead to prejudice and put the jobs of some at risk. Even if such a scheme was remotely feasible and people were willing to join it, it is not clear where the resources would come from to fund the certification process which presumably would be required.

Can we protect child health with HAP alerts?

The community is now increasingly aware and concerned about the threat to both short and long term health of children. The incontrovertible evidence from Hong Kong surveys and longer term follow-up in other countries shows that growing up in pollution, even at levels well below those experienced in Hong Kong, will cause permanent impairment of lung growth and development in children and adolescents.

There is a demand for guidance on many issues, including how to manage school sports events.[17] We believe this is a difficult and perhaps impossible dilemma to resolve through simple advisories. The evidence from cohort studies in the United States points to

impairment of lung development in some adolescents incurred by living in pollution levels which are associated with proximity to busy roadways.[1]

The principal cause of damage to children is caused by average daily high levels not simply the less common very high pollution days. There is no question that we should try to avoid exposing children and adolescents to extremely high pollutant levels, especially during sporting events, but parents should not be misled into thinking that a HAP alert, or moving events indoors, at any level of pollution, will influence long term respiratory and other health problems which may result from usual daily exposures in Hong Kong. The biggest health impact of pollutants will occur over the larger number of near average pollution days. This includes those when endurance training takes place, at lower pollutant levels than those which might lead to cancellation of sports events.

When is it safe to exercise?

The lack of practical usefulness of the HKAPI and likely failure of an alert in relation to sports events is demonstrated by the pattern of pollutants on the day of the Hong Kong (Standard Chartered) Marathon on 4 Marathon on 4 March 2007 (Figure 10). If we based the alert on the WHO 24 hour guideline then we would just accept the early morning levels as permissible and no alert would be issued. However during the period of the running events general and roadside particulates rose to 60% above this level.

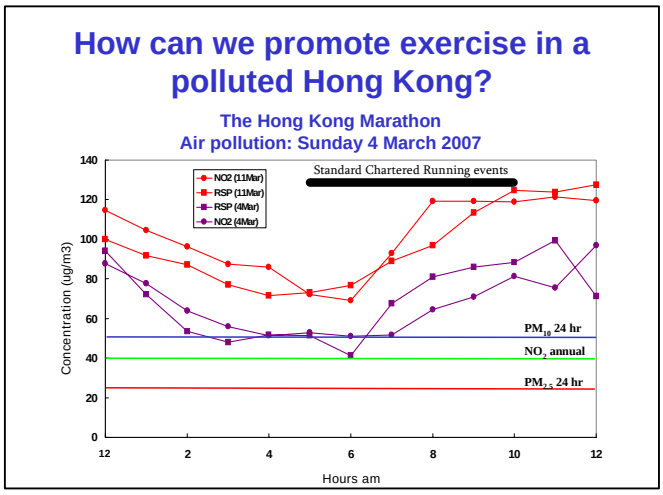


Figure 10: The rapidly changing nature of hourly pollutant levels emphasises the difficulty of "predicting" HAP which would trigger an alert. On 4 March the early morning levels would justify an alert; at the start of the running events particulate levels just approximated to the upper bound of the WHO 24 hour guide, but within an hour were rising sharply and reached very high levels before completion of the events.

If the races had been run the following weekend the runners would have faced RSP levels which reached 140% (120µg/m^3) above the WHO 24 hour guideline. The Environmental Protection Department has advised that an API of 200 is an appropriate level for schools to abandon sports events we believe that this is advisory is unsafe. However the HKAQO 24 hour level for particulates is 180µg/m^3 so on neither of these days would an API based on the HKAQO have triggered an alert. However the levels recorded during the marathon would predictably have adverse effects on the normal physiological functioning of even young fit healthy individuals.

What are current trends in Hong Kong's pollutants?

The levels of pollution in Hong Kong, based on general and roadside levels of particulates and nitrogen dioxide, are very high and more or less stable on an annual basis. We have repeatedly pointed out that, because of yearly random fluctuations in pollutants, government claims (based on selecting two data points) that there have been significant reductions, are invalid. There is no reliable current evidence that pollution trends are improving.

Statistically fitted curves to particulate data during the past nine years show no significant trend. The curves are essentially flat (Figure 11). Even if the government claims were true and small reductions have been achieved, albeit difficult to measure, the health protection offered by these small changes would be negligible compared with the burden of disease created by average levels.

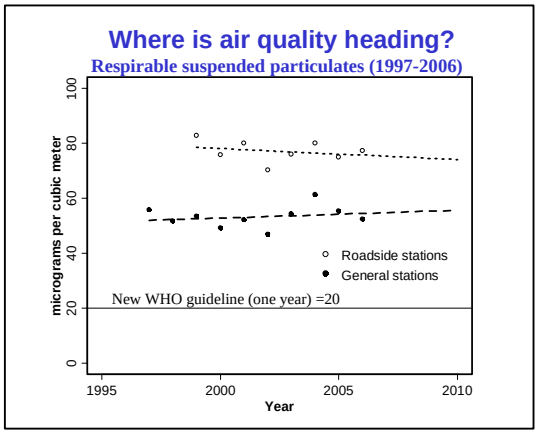


Figure 11: Changes in average ambient annual levels of pollutants such as particulates cannot be reliably assessed by selecting two points on the timescale. Appropriate numerical methods should be used to take account of uncertainty associated with the underlying trends. The curves in this figure are derived from a log linear regression model. They show that there is no significant downturn in particulate pollution and no trend which would reach WHO guidelines within the foreseeable future.

For sulphur dioxide (SO_2) levels, the gains in abatement made in the early 1990s are now being lost. Recent hourly levels of SO_2 in many sites in Hong Kong have been well over 100µg/m^3 compared with the WHO 24 hour guideline of 20µg/m^3.

Until and unless we can demonstrate a marked statistically significant downturn in the trends of all pollutants, which has a clear relationship to health protection, there should be a moratorium on statements which mislead the public. HAP alerts will not make any material difference to the trends illustrated here.

Conclusions

For discussion and debate, we suggest that:

- HAP alert days in Hong Kong would be a highly inefficient use of scarce resources.
- The estimated costs of any HAP alert system and the low level of benefits clearly indicate that these resources should be re-allocated to *efficient* pollution abatement strategies. They should particularly be allocated to *mandatory actions* on clean transportation and fuels and other interventions which need to be part of a comprehensive air quality strategy.
- HAP alert days will not work and will be rejected by an informed public, legislature and government when they understand the implications of the cost-benefit equation.

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