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ACE Paper 2/2013
For discussion on 18 March 2013

Review of the Air Pollution Index Reporting System

PURPOSE

This paper seeks Members' views on the proposal to replace the existing Air Pollution Index (API) by a new health-based Air Quality Health Index (AQHI) to tie in with the implementation of the new Air Quality Objectives (AQOs).

BACKGROUND

2. Our API system, which has been in use since 1995, aims to communicate to the public the air quality level in a simple manner by converting complicated air pollution data into a number ranging from 0 to 500. Referencing to the then Pollution Standard Index adopted by the United States, it anchors to the prevailing Air Quality Objectives (AQOs) for nitrogen dioxide (NO_2), sulphur dioxide (SO_2), ozone (O_3), carbon monoxide (CO) and respirable suspended particulates (RSP or PM_{10}) with the highest index among those determined from these air pollutants reported as the API of the hour. Details on its calculation methodology are at **Annex A**.

3. To tie in with the tightening of the AQOs, we will update and improve our API reporting system for better communication of the air quality information to the public. In April 2008, we commissioned a team of health and atmospheric science experts from local universities to review the API reporting system. The review was completed and the findings have also been published in a peer-reviewed international

journal[1]. The major findings of the review are as follows:

(a) There is no standard way to communicate air pollution information to the public in the form of an index. An API could either be AQO-based or health-based. The latter has the advantage of using local air pollution-related health data for reporting the health risks of air pollution in an aggregate and holistic manner.

(b) Canada[2] is the pioneer to recognize the cumulative nature of air pollution on health by using a health-based API system. Its AQHI was developed in early 2000s. In the European Union (EU), similar health-based air pollution indices are being developed and used in France (Provence-Alpes-Cote d'Azur region)[3], Central Europe and Greece[4] (Athens and Thessaloniki).

THE PROPOSED AQHI SYSTEM

4. The review has recommended the AQHI system as a model for Hong Kong by using local air pollution and health data. The following are the key features of the proposed AQHI system –

(a) the aggregated increase in hospital admission risks of the air pollutants, namely, NO_2, O_3, particulate matters (RSP and fine suspended particulates (FSP or $PM_{2.5}$), whichever poses a higher health risk) and SO_2, are used for determining the AQHI cut-points to reflect their combined health effects at different air pollution levels;

(b) the AQHI bands are reported in a scale from 1 to 10+ and are grouped into 5 health risk categories, namely, low, moderate, high, very high and serious. Specific health advice will be issued to people with different susceptibility to air pollution when AQHI reaches high or above categories. Details of the health advice are at **Annex B**;

[1] Wong TW, Tam WWS, Yu ITS, Lau AKH, Pang SW, Wong AHS "Developing a risk-based air quality health index". Atmospheric Environment, Accepted for publication. Available at: http://www.sciencedirect.com/science/article/pii/S1352231012006553

[2] http://www.ec.gc.ca/cas-aqhi/

[3] http://www.sante2air.eu/air/en/

[4] http://lap.physics.auth.gr/forecasting/index_aq.php

(c) the health risk levels associated with the short-term AQG of the World Health Organization (WHO) for the air pollutants[5] are used for determining the AQHI cut-points for the high and very high categories, reflecting corresponding increase in aggregate health risks of 11.29% and 12.91% increase in hospital admissions (due to respiratory and heart illnesses) respectively; and

(d) it will be calculated on the basis of 3-hour moving average pollutant concentrations.

Details of the proposed AQHI system are at **Annex C**.

5. The proposed AQHI system features the following improvements over the current API system:

(a) it is a health risk-based reporting system making reference to relationship between local air pollution and hospital admissions, and thus could provide a more useful reference from health perspective;

(b) it takes into account the combined effects of the concerned air pollutants;

(c) the use of 3-hour moving average pollutant concentrations in calculating the AQHI enables the change of air quality be closely followed and hence will provide more timely health risk communication to the public; and

(d) each AQHI value is associated consistently with its respective health risk level that helps the public to better understand the extent of the adverse health effects and the precautionary actions that may be required.

6. Using the air quality data between 2005 and 2011, we have compared the operation of the AQHI with the current API (under two scenarios – one is benchmarked on the existing AQOs and the other on the new AQOs). The results are summarized in **Annex D**. The tightening of the AQOs will substantially increase the number of hours that the air pollution is rated at high or very high levels even when there are no material changes in air pollutant concentrations.

7. Some key observations of the comparison are summarized below –

[5] WHO AQGs for the four major pollutants: 129.8 $\mu g/m^3$ for NO_2 (adjusted from the 1-hour WHO AQG of 200 $\mu g/m^3$), 100 $\mu g/m^3$ for O_3, 50 $\mu g/m^3$ for PM_{10}, and 20 $\mu g/m^3$ for SO_2.

(a) at the ambient level, the proposed AQHI system will increase the number of days in the unacceptable categories at general air quality stations in 2011 from 22 to 129. The number of days for API exceeding 100 in 2011 will rise from 22 to 86 days if the current API system is maintained under the new AQOs.

(b) at the roadside, the number of unacceptable days in 2011 will rise from the existing 172 days to 227 days if the proposed AQHI system is used. The corresponding figure for the API system under the new AQOs is 237 days.

8. Under the proposed AQHI system, the number of days reading "Very High" and "Serious" will be 65 days and 18 days respectively, in 2011 at the ambient level, and 135 days and 22 days respectively, at roadside level. When the AQHI reaches "Very High" or "Serious" categories, our advice for the relevant groups of people will be as follows:

(a) People susceptible to air pollution (e.g. children and the elderly, those with existing heart or respiratory illnesses):

When the AQHI is at "Very High", this group should reduce to the minimum outdoor physical exertion, and the time of staying outdoors, especially in areas with heavy traffic. Outdoor physical exertion should be avoided when AQHI is "Serious".

(b) Outdoor workers and general public:

For outdoor workers, their employers are advised to assess the risk of outdoor work, and take appropriate preventive measures to protect the health of their employees. When the AQHI is at "Very High", employers of outdoor workers performing heavy manual work are advised to take appropriate preventive measures to protect the health of their employees through such means as reducing outdoor physical exertion, and the time staying outdoors, especially in areas with heavy traffic. When the AQHI is "Serious", employers of all outdoor workers are advised to take appropriate preventive measures to protect the health of their employees through such means as reducing outdoor physical exertion, and reducing the time of staying outdoors, especially in areas

with heavy traffic.

When the AQHI is at "Very High", the general public should reduce outdoor physical exertion, and to reduce the time of staying outdoors, especially in areas with heavy traffic. When the AQHI is "Serious", the general public should reduce to the minimum outdoor physical exertion, and the time of staying outdoors, especially in areas with heavy traffic.

9. The WHO has reviewed the proposal and considered that the proposed AQHI system can facilitate people's understanding of impacts of air pollution and be instrumental for health protection. They welcome the use of the WHO Air Quality Guidelines (AQGS) as the basis for defining the AQHI risk boundaries.

WAY FORWARD

10. Since the proposed AQHI system is scientifically more robust and more effective in communicating the health risk associated with air pollution to the public, we plan to adopt it to replace our current API reporting system. If it is adopted, Hong Kong will be the first economy in the Asia-Pacific region to put forward a health risk-based system for air quality communication.

11. To facilitate a smooth implementation of the new AQHI system, we need to ensure the public and relevant stakeholders have a good understanding of the proposed changes. We shall carry out the necessary preparatory work in the coming months, including :

(a) consult the health professionals, academics, green groups and other key stakeholders on the new AQHI system and engage relevant parties to promote the new system and educate the public of the significance of AQHI;

(b) liaise with relevant Government bureaux/departments to prepare and update guidelines and response plans together with medical doctors/practitioners, employers of outdoor workers, schools, nurseries and elderly homes for them to follow during poor AQHI days;

(c) provide briefing sessions to relevant stakeholders such as schools to explain the AQHI system and the associated health advice; and

(d) upgrade the back-end computing system and revamping EPD's website, interactive voice recording system, mobile alert system, etc. for dissemination of the new AQHI information. A soft launch for the AQHI will be considered when the preparatory work is mature to facilitate us to solicit users' feedback with a view to further enhancing the implementation strategy for the AQHI as necessary;

Subject to the progress of these preparatory work, we expect that the AQHI system could be launched in early 2014 to tie in with the launch of the new AQOs.

ADVICE SOUGHT

12. Members are invited to offer their views on the proposed new AQHI system and our proposed implementation plan.

Environmental Protection Department
March 2013

Annex A

EXISTING AIR POLLUTION INDEX SYSTEM

The Air Pollution Index (API) is a simple way of describing air pollution levels. In Hong Kong, the API converts air pollution data from several types of pollutants into a value ranging from 0 to 500. The real-time APIs for general and roadside stations are both reported on an hourly basis. These indices are calculated by comparing the measured concentrations of the major air pollutants with their respective health related AQOs established under the APCO. These pollutants are nitrogen dioxide, sulphur dioxide, ozone, carbon monoxide and respirable suspended particulates. An index is calculated for each of the five pollutants and the highest index is reported as the API of that hour.

API Band	**API**	**Air Quality Level**	**Advice to Public**	
			General API	**Roadside API**
Low	0-25	Air quality well within all AQOs.	No response action is required.	
Medium	26-50	Air quality within all AQO values.	No response action is required.	
High	51-100	Air quality within the short-term AQO values but worse than the long-term AQO values.	No immediate response action is suggested -- Long-term effects may, however, be observed if exposed at this level persistently for months or years	
Very High	101-200	Air quality worse than both short-term and long-term AQO values.	Persons with existing heart or respiratory illnesses (such as coronary heart and cardiovascular diseases, asthma, chronic bronchitis and chronic obstructive airways diseases)are advised to reduce physical exertion and outdoor activities	Persons with existing heart or respiratory illnesses (such as coronary heart and cardiovascular diseases, asthma, chronic bronchitis and chronic obstructive airways diseases) are advised to avoid prolonged stay in areas with heavy traffic. If it is necessary to stay in

API Band	API	Air Quality Level	Advice to Public	
			General API	**Roadside API**
				streets or roads with heavy traffic, they are advised to reduce physical exertion as far as possible.
Severe	201-500	Air quality significantly worse than both short-term and long-term AQO values.	The general public are advised to reduce physical exertion and outdoor activities	The general public are advised to avoid prolonged stay in areas with heavy traffic. If it is necessary to stay in streets or roads with heavy traffic, they are advised to reduce physical exertion as far as possible.

Annex B

HEALTH ADVICE FOR THE PROPOSED AIR QUALITY HEALTH INDEX SYSTEM

<table>
<tr><th rowspan="2">Health Risk</th><th rowspan="2">AQHI band</th><th rowspan="2">Added Health Risk (%)</th><th colspan="2">(i) People who are sensitive to Air Pollution</th><th>(ii) Outdoor Workers*</th><th>(iii) General Public</th></tr>
<tr><th>(a) People with existing heart or respiratory illnesses</th><th>(b) Children and the Elderly</th><th></th><th></th></tr>
<tr><td rowspan="3">Low</td><td>1</td><td>0 - 1.88</td><td rowspan="3">No response action is required.</td><td rowspan="3">No response action is required.</td><td rowspan="3">No response action is required.</td><td rowspan="3">No response action is required.</td></tr>
<tr><td>2</td><td>>1.88 - 3.76</td></tr>
<tr><td>3</td><td>>3.76 - 5.64</td></tr>
<tr><td rowspan="3">Moderate</td><td>4</td><td>>5.64 - 7.52</td><td rowspan="3">No response action is normally required. Individuals who are experiencing symptoms are advised to consider reducing outdoor physical exertion.</td><td rowspan="3">No response action is required.</td><td rowspan="3">No response action is required.</td><td rowspan="3">No response action is required.</td></tr>
<tr><td>5</td><td>>7.52 - 9.41</td></tr>
<tr><td>6</td><td>>9.41 - 11.29</td></tr>
</table>

* The advice applies to outdoor workers who do not belong to (i).

Health Risk	AQHI band	Added Health Risk (%)	(i) People who are sensitive to Air Pollution		(ii) Outdoor Workers*	(iii) General Public
			(a) People with existing heart or respiratory illnesses	(b) Children and the Elderly		
High	7	>11.29 - 12.91	People with existing heart or respiratory illnesses (such as coronary heart disease and other cardiovascular diseases, asthma and chronic obstructive airways diseases including chronic bronchitis and emphysema) are advised to **reduce** outdoor physical exertion, and to **reduce** the time of their stay outdoor, especially in areas with heavy traffic. They should also seek advice from a medical doctor before participating in sport activities and take more breaks during physical activities.	Children and the elderly are advised to **reduce** outdoor physical exertion, and to **reduce** the time of their stay outdoor, especially in areas with heavy traffic.	No response action is required.	No response action is required.
Very High	8	>12.91 - 15.07	People with existing heart or respiratory illnesses are advised	Children and the elderly are advised to **reduce to the**	Employers of outdoor workers performing heavy manual work	The general public is advised to **reduce** outdoor physical

Health Risk	AQHI band	Added Health Risk (%)	(i) People who are sensitive to Air Pollution		(ii) Outdoor Workers*	(iii) General Public
			(a) People with existing heart or respiratory illnesses	**(b) Children and the Elderly**		
	9	>15.07 - 17.22	to **reduce to the minimum** outdoor physical exertion, and to **reduce to the minimum** the time of their stay outdoor, especially in areas with heavy traffic.	**minimum** outdoor physical exertion, and to **reduce to the minimum** the time of their stay outdoor, especially in areas with heavy traffic.	are advised to assess the risk of outdoor work, and take appropriate preventive measures to protect the health of their employees such as **reducing** outdoor physical exertion, and **reducing** the time of their stay outdoor, especially in areas with heavy traffic .	exertion, and to **reduce** the time of their stay outdoor, especially in areas with heavy traffic.
	10	>17.22 - 19.37				
Serious	10+	>19.37	People with existing heart or respiratory illnesses are advised to **avoid** outdoor physical exertion, and to **avoid** staying outdoor, especially in areas with heavy traffic.	Children and the elderly are advised to **avoid** outdoor physical exertion, and to **avoid** staying outdoor, especially in areas with heavy traffic.	Employers of all outdoor workers are advised to assess the risk of outdoor work, and take appropriate preventive measures to protect the health of their employees such as **reducing** outdoor physical exertion, and **reducing** the time of their stay outdoor, especially in areas with heavy traffic	The general public is advised to **reduce to the minimum** outdoor physical exertion, and to **reduce to the minimum** the time of their stay outdoor, especially in areas with heavy traffic.

Note:

1. As the health effects on individuals may vary, you should seek advice from a medical doctor if you are in doubt or feel uncomfortable. If you are suffering with existing heart or respiratory illnesses (such as coronary heart disease and other cardiovascular diseases, asthma and chronic obstructive airways diseases including chronic bronchitis and emphysema), you should follow your doctor's advice on the amount of physical exercise and the management of your illness under different air quality health index bands. If you are a smoker, you should quit smoking now!

2. Outdoor workers need to be aware of the potential impact on their health at times when the AQHI reaches “Very High” or “Serious” health risk, and seek advice from a medical doctor if they are in doubt of their health condition or suffer from any chest or breathing discomfort. They should inform their employers of the medical advice so that suitable work arrangements can be worked out.

3. The amount of physical exercise that should be performed differs according to the individual’s physical capacity, and should be tailored to one’s own physical condition. Ask your doctor for advice.

4. With the consent of the Study Team, the health advices have been revised slightly from the study report and be more prescriptive taking into account comments from stakeholders.

Annex C

PROPOSED AIR QUALITY HEALTH INDEX

The Proposed Air Quality Health Index (AQHI) is calculated by adding the increased hospital admission risks associated with the major air pollutants, viz., NO_2, O_3, PM_{10} (or $PM_{2.5}$ whichever the higher), and SO_2. The thresholds for issuing health advice is determined by the total increase in hospital admission risks for the four selected air pollutants being at concentrations at the respective short-term WHO AQGs.[1] Accordingly, the thresholds for the high risk groups and the whole population are 11.29% and 12.91% respectively. Air pollution causing these health risk increases will be classified as "high" and "very high" in the proposed AQHI system.

2. The AQHI bands are reported on a scale of 1 to 10 and >10 and are grouped into five health risk categories. The public, in addition to following the health advice to be issued for each of these health risk categories, may also make adjustments to their physical activities according to their own health conditions.

Health Risk Category	**AQHI Band**	**Added Health Risk (%)**
Low	1	0 - 1.88
	2	>1.88 - 3.76
	3	>3.76 - 5.64
Moderate	4	>5.64 - 7.52
	5	>7.52 - 9.41
	6	>9.41 - 11.29
High	7	>11.29 - 12.91
Very High	8	>12.91 – 15.07
	9	>15.07 – 17.22
	10	>17.22 – 19.37
Serious	10+	>19.37

3. Similar to the EU[1], to communicate the long-term health risks to the public, an annual index, which is determined by dividing the annual concentrations of the

[1] http://www.airqualitynow.eu/

pollutants with their respective WHO AQGs, will be made accessible via a suitable link in the AQHI webpage.

4. Before finalizing the proposal, the study team has consulted the Environment Canada / Health Canada and incorporated their views and comments in the revision. The proposal has also been peer reviewed when it was submitted for publication in an international renowned environmental science journal.

Annex D

COMPARISON OF AIR QUALITY READING UNDER THE API AND AQHI SYSTEMS

(a) Hourly Statistics

	API system (under different benchmarks)			AQHI			
	The number of hourly API>100			AQHI of "High" to "Serious"	High	Very High	Serious
	Current AQOs	New AQOs	WHO AQG				
Roadside stations							
2005	419	2159	8631	[1]	-	-	-
2006	629	2318	8509	[1]	-	-	-
2007	1007	2569	8333	[1]	-	-	-
2008	1183	1873	8518	[1]	-	-	-
2009	1598	1280	7916	1416	672	680	64
2010	2428	1807	6463	1712	751	868	93
2011	3029	1846	8191	2086	1041	968	77
General stations							
2005	129	1833	8051	1036	392	540	104
2006	141	1568	8217	1079	476	505	98
2007	159	1722	8249	1030	399	552	79
2008	92	1525	8388	978	412	482	84
2009	57	787	7252	805	345	403	57
2010	151	689	7358	745	289	374	82
2011	108	943	7519	872	437	377	58

Unit: Number of hours

[1] Due to the absence of ozone monitoring data at roadside stations before 2009, AQHIs statistics from 2005 to 2008 are not available

(b) Daily Statistics

	API system			AQHI			
	The number of daily API>100			AQHI of "High" to "Serious"	High	Very High	Serious
	Current AQOs	New AQOs	WHO AQG				
Roadside stations							
2005	43	135	365	[1]	-	-	-
2006	51	149	364	[1]	-	-	-
2007	68	153	356	[1]	-	-	-
2008	85	145	364	[1]	-	-	-
2009	102	138	358	157	47	93	17
2010	141	188	308	175	57	96	22
2011	172	237	357	227	70	135	22
General stations							
2005	21	125	350	126	34	66	26
2006	21	113	359	137	36	75	26
2007	21	111	360	134	44	70	20
2008	21	115	361	122	35	64	23
2009	22	74	340	109	32	61	16
2010	19	67	338	93	23	55	15
2011	22	86	332	129	46	65	18

Unit: Number of days

[1] Due to the absence of ozone monitoring data at roadside stations before 2009, AQHIs statistics from 2005 to 2008 are not available