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River Pollution Relationship to the National Health Indicated by Under-Five Child Mortality Rate: A Case Study in Malaysia

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ABSTRACT

The trend of global under-five child mortality rate showed a steady decrease at -3.14% per year approaching the United Nations millennium development goals target (-4.0% reduction per year from 1990-2015). This rate is usually inversely proportional to the nations GDP. However, the progress in the recent years (2006-2012) in Malaysia has raised a disturbing concern with an annual average increment of +0.81% per year. Thus, there is an urgent need to identify the reasons of such risky ecosystem. By analyzing recorded data on river pollution from 2007-2012, we found that river pollution has high correlation with the gross domestic products, not at the same year, but for two years prior that indicates a lag time. We also found that under-five child mortality has strong correlation with the river pollutions. The development-pollution-health triangular cycle needs to be put in a balanced to ensure the nation prosperity and sustainability of the nation.

INTRODUCTION

United Nation (UN) has set eight millennium development goals (MDG) for the global future. One of these goals is to decrease global child mortality, which is one of the country's best health indicators. The MDG is aimed to reduce the child mortality at the rate of approximately -4% per year from 1990 to 2015. The current average of the reduction rate is -3.14% (±0.95), taking into account of a worldwide progress from 1990 to 2012. This indicates that serious and strong commitment that had been given by majority of the governments. It is worth-mentioning that the reduction rates are fairly well distributed among all nations, traversing all standards of living from USD 400 to 40 cents per day income. In total, under-five mortality rate (U5MR) has decreased by 49%, from an estimated rate of 90 deaths per 1000 live births in 1990 to 46 deaths per 1000 live births in 2013[1]. Although the average value of U5MR has accelerated (from -1.2% a year over the period 1990–1995 to 4.0% for 2005–2013), which has been estimated about 17,000 fewer children died every day in 2013 than in 1990 [2], it still remained insufficient to attain MDG #4.

In a country like Kenya, the data of under-five-year-old child mortality over live births were acquired from highly professional women interviewers that personally interviewed mothers to gather the figures [5,6]. Likewise, the data for U5MR in other countries were constantly collected or been reported by legitimate local health authorities, and were properly recorded. These high-integrity datasets are made available online by the WHO.

Despite the world epidemics like mumps and flu pandemic in 2009, and the Ebola virus disease in 2013 that claimed more than 100,000 lives, strong statistical data showed that the global health is improving [3,4]. The acceleration of the decreasing rate for U5MR is seen worldwide at the average of -1.98% < -2.56% <

-3.59% < -3.95% and < -3.97% for every five years period from 1990-1994, 1995-1999, 2000-2004, 2005-2009, and 2010-2012, respectively. These reductions are usually disproportionate with the national income indicated by gross domestic products (GDP). Therefore, it is undoubted that the global U5MR reduction rate has been more than doubled in the recent years of 2003-2012 than it was in the first 10 years period after the launching of MDG. However, if the current acceleration rate persists the MDG #4, the aim to reduce two-third of child mortality from 90 (in 1990) to 30 per every 1000 birth by 2015, will be met in 2028. Thus, there is an urgent need to i) to identify the lag causes, and ii) to overcome the challenges in order to achieve the target.

MATERIALS AND METHODS

Measuring U5MR progress

How do we measure the reduction progress for U5MR? We evaluated the trend of global U5MR rate for 10 years from 2003-2012 (2013 was excluded because lack of full set of data). A simple and practical way to measure the recent progress of a country can be implemented by calculating the average of reduction rate in the first five years (2003-2007) denoted as R_1 and comparing it with the next five years period (2008-2012) denoted as R_2. The commitment and progress acceleration of a nation to reduce the U5MR can be viewed by ΔR, from the first half to the later part of these 10 years, which was then defined by $R_2 - R_1$ (table 1).

Analyzing heavy metals pollution

We acquired processed and original data on river monitoring program in the period of 10 years (2003-2012) from the Department of Environment (DOE) of Malaysia. The datasets are either in the form of averaged value for one year, or in a quarterly form value, for processed and original data, respectively. Linear regression method was used to identify the correlations between the annual number of class III and IV rivers and GDP minus two years data acquired from the World Bank. Correlation was also observed between the river pollution and the U5MR data acquired from the WHO.

RESULTS AND DISCUSSION

Progresses on U5MR for 189 countries were summarized in table 1. On top of the list are many middle-income countries or developing country (by UN definition) like Uruguay (-8.00%), South Africa (-7.47%), Macedonia (-6.82%), and Swaziland (-5.69%). Malnutrition was identified as 58% contributor for developing countries and (one-fifth contributor for U5MR in Uruguay) back in 1995 [7], major development in South Africa from administration level of health institutions to education and preventions especially in fighting HIV and tuberculosis epidemics have benefited progress in improving U5MR [8,9]. At the same time, however, child's death rate will increase if they were born to a mother with lack of education, a place with low facilities or a family with unstable condition. Although improvements have been made in the treatment against child's diseases related to the poor, infectious diseases still remained highly prominent in Sub-Saharan Africa and Southern Asia. Roughly in 2013, about two million children were killed by the preeminent causes of death known as pneumonia, diarrhea and malaria, responsible for almost a third of global under-five deaths [10].

Conflicts and political fragility (weakened capacity to sustain core state functions) contribute to higher U5MR. One fifth of all under-five deaths in 2013 occur in countries currently classified as fragile and conflict affected contexts. From 20 countries with the highest under-five mortality rates, 11 are affected markedly by conflict or violence or are in fragile situations. Six of these are also among the 20 countries with the lowest annual rate of reduction since 1990 (excluding countries with fewer than 10,000 live births in 2013), indicating little progress where it is needed most.

High-income country like Qatar (GDP/capita = USD160/day) had progressed beyond the average line with R_1 = -4.16% and R_2 = -4.47%. The ΔR for Qatar is -0.31%. Started with U5MR of 11.1, Qatar achieved 7.4 in 2012. Japan (GDP/capita = USD100/day) on the other hand was having a slow progress with R_1 = -3.11% and R_2 = -2.87%. This resulted an increase in ΔR, as much as +0.24%. This makes sense because the task of reducing small number of U5MR, which was 4 in 2003 to 3 in 2012, is a lot harder than reducing bigger number of U5MR. The same situation were observed in several countries like Singapore (from 3.9 to 2.9), Iceland (from 4 to 2.3), Sweden (from 4.1 to 2.9), Germany and France (from 5.4 to 4.1), where the ΔR are +4.5%, +1.03%, +1.22%, +0.63% and +1.51%, respectively, showing deceleration in their progress. Finland, however, managed to breakthrough by reducing small U5MR from 4.3 to 2.9, marking ΔR of -0.58%.

65 Low-income countries with <USD 5 per day of income had an average ΔR = +0.28% (±2.06). Nevertheless, from these countries Palestine (West Bank and Gaza) has made amazingly good progress with ΔR = -0.34%, reducing U5MR from 29.9 in 2003 to 22.6 in 2012. This is despite embargoes that lead to daily nutritional consumption deficiencies of folic acid, vitamin D and minerals [11]. Other good examples are lesotho (-3.6) > Rep. Congo (-2.41) > Bangladesh (-1.29) > Sierra Leone (-0.82) > Mozambique (-0.73) > Pakistan (-0.16) > and India (-0.14).

High estimated new birth countries, typically India and China had some difficulties in fighting malaria, pertussis, tetanus and measles to reduce U5MR in such a large populations with R_1 = -3.93% and -8.74%, and R_2 = -4.07% and -6.88%, respectively [12]. These resulted in slow or stagnant progress with ΔR = -0.14% and +1.86% for India and China, respectively. The progress on U5MR for India and china are really important, as their estimated new birth in 2013 were 25 and 16.3 million, respectively. On the other side, low estimated new birth countries also hit challenges as reducing U5MR in small new born numbers are also not easy. Nevertheless, countries like Lithuania, Poland, Barbados, United Kingdom and Bahamas have shown good progress in reducing the U5MR.

Major improvements in child survival since 1990 are partly attributable to affordable, evidence-based interventions against the leading infectious diseases, such as immunization, insecticide-treated mosquito nets, and rehydration treatment for diarrhea, nutritional supplements and therapeutic food. Accelerating the reduction in U5MR is possible by expanding effective preventive and curative interventions that target the main causes of post-

Table 1. Progress of U5MR reduction in the period of 2003-2012, measured in ΔR

	Country	R_1	R_2	ΔR		Country	R_1	R_2	ΔR
1.	Uruguay	-3.67	-11.67	-8.00	96.	Tajikistan	-3.57	-3.37	0.20
2.	South Africa	-1.70	-9.17	-7.47	97.	Morocco	-3.95	-3.72	0.23
3.	Macedonia	-2.93	-9.75	-6.82	98.	Afghanistan	-2.68	-2.45	0.23
4.	Swaziland	-1.64	-7.33	-5.69	99.	Dominican Republic	-3.26	-3.03	0.24
5.	Lithuania	-3.96	-9.50	-5.54	100.	Japan	-3.11	-2.87	0.24
6.	Lesotho	0.16	-3.60	-3.76	101.	Indonesia	-4.34	-4.09	0.25
7.	Bosnia / H'vina	-1.34	-4.86	-3.53	102.	Russia	-6.87	-6.61	0.26
8.	Poland	-3.31	-6.77	-3.46	103.	Ghana	-3.12	-2.85	0.27
9.	Barbados	1.03	-1.75	-2.78	104.	Honduras	-4.26	-3.94	0.31
10.	Namibia	-4.94	-7.54	-2.61	105.	Slovenia	-4.85	-4.48	0.37
11.	Congo, Dem. Rep.	-0.39	-2.80	-2.41	106.	Brunei	-1.57	-1.20	0.37
12.	Somalia	-0.29	-2.59	-2.30	107.	Andorra	-3.74	-3.37	0.37
13.	Solomon Islands	-0.06	-2.33	-2.28	108.	Uganda	-6.52	-6.14	0.37
14.	Kyrgyz Republic	-3.96	-6.18	-2.22	109.	Ethiopia	-6.64	-6.26	0.37
15.	St. Lucia	0.88	-1.31	-2.19	110.	Guatemala	-3.86	-3.48	0.38
16.	United Kingdom	-1.64	-3.71	-2.07	111.	Cyprus	-6.13	-5.74	0.39
17.	Bahamas	0.56	-1.47	-2.03	112.	Zambia	-5.50	-5.03	0.47
18.	Montenegro	-6.50	-8.10	-1.59	113.	Gambia	-4.07	-3.56	0.51
19.	Burkina Faso	-4.67	-6.21	-1.54	114.	Belgium	-2.73	-2.22	0.51
20.	Mauritius	0.14	-1.38	-1.52	115.	Guinea	-4.45	-3.94	0.51
21.	Gabon	-2.27	-3.66	-1.39	116.	South Korea	-5.48	-4.95	0.53
22.	Angola	-1.28	-2.66	-1.38	117.	Eritrea	-4.60	-4.05	0.55
23.	S. Vincent / Grenadines	1.24	-0.08	-1.32	118.	Tunisia	-5.17	-4.62	0.55
24.	Congo, Rep.	-1.31	-2.61	-1.30	119.	Tanzania	-7.47	-6.90	0.57
25.	Bangladesh	-5.80	-7.10	-1.29	120.	Antigua and Barbuda	-4.04	-3.45	0.59
26.	Kazakhstan	-6.66	-7.89	-1.23	121.	Czech Republic	-4.76	-4.16	0.60
27.	Seychelles	0.00	-1.18	-1.18	122.	Brazil	-6.97	-6.36	0.61
28.	Papua New Guinea	-1.44	-2.61	-1.17	123.	Germany	-2.47	-1.84	0.63
29.	Norway	-4.26	-5.41	-1.16	124.	Samoa	-1.63	-0.98	0.65
30.	Croatia	-4.24	-5.38	-1.14	125.	Cuba	-3.63	-2.98	0.65
31.	Canada	-0.98	-2.12	-1.14	126.	Yemen	-4.17	-3.50	0.67
32.	Comoros	-1.73	-2.86	-1.12	127.	Suriname	-3.90	-3.22	0.68
33.	Denmark	-3.15	-4.26	-1.11	128.	Peru	-6.54	-5.85	0.70
34.	Chad	-1.51	-2.54	-1.03	129.	Albania	-4.61	-3.83	0.78
35.	Kenya	-3.22	-4.13	-0.91	130.	S. Tome / Principe	-4.35	-3.57	0.78
36.	United States	-0.99	-1.86	-0.87	131.	Iran	-5.84	-5.04	0.79
37.	Kiribati	-0.89	-1.74	-0.85	132.	Venezuela	-3.16	-2.31	0.85
38.	Sierra Leone	-1.80	-2.62	-0.82	133.	Malta	-0.86	0.00	0.86
39.	Mauritania	-2.06	-2.80	-0.74	134.	Nicaragua	-4.32	-3.46	0.86
40.	Mozambique	-4.67	-5.40	-0.73	135.	Nepal	-5.85	-4.98	0.88
41.	Estonia	-8.70	-9.41	-0.71	136.	Benin	-4.68	-3.79	0.88
42.	Togo	-1.71	-2.41	-0.70	137.	Australia	-2.45	-1.55	0.89
43.	Djibouti	-2.21	-2.92	-0.70	138.	Luxembourg	-6.94	-6.00	0.93
44.	Guyana	-1.92	-2.62	-0.70	139.	Senegal	-7.58	-6.63	0.95
45.	Netherlands	-3.25	-3.89	-0.63	140.	Kuwait	-1.67	-0.71	0.96
46.	Cote d'Ivoire	-2.32	-2.91	-0.59	141.	Fiji	-0.87	0.09	0.96
47.	Finland	-3.11	-3.69	-0.58	142.	Thailand	-4.74	-3.77	0.97
48.	Bahrain	-1.76	-2.33	-0.57	143.	Hungary	-4.95	-3.98	0.98
49.	Trinidad / Tobago	-2.26	-2.83	-0.57	144.	Iceland	-4.89	-3.86	1.03
50.	Vanuatu	-2.41	-2.96	-0.55	145.	Georgia	-4.47	-3.43	1.04
51.	Guinea-Bissau	-2.26	-2.80	-0.54	146.	South Sudan	-4.95	-3.89	1.06
52.	Philippines	-2.33	-2.83	-0.50	147.	Moldova	-4.67	-3.56	1.11
53.	Panama	-2.57	-3.05	-0.48	148.	Timor-Leste	-5.60	-4.48	1.12
54.	Burundi	-3.04	-3.51	-0.47	149.	Costa Rica	-2.14	-0.97	1.16
55.	Zimbabwe	-0.83	-1.30	-0.46	150.	San Marino	-4.45	-3.28	1.17
56.	Tonga	-2.70	-3.12	-0.42	151.	Mali	-5.12	-3.90	1.21
57.	Ukraine	-4.16	-4.54	-0.38	152.	Sweden	-3.77	-2.54	1.22
58.	Iraq	-2.03	-2.38	-0.34	153.	Bolivia	-5.69	-4.46	1.23
59.	West Bank and Gaza	-2.12	-2.46	-0.34	154.	Algeria	-4.91	-3.66	1.25
60.	Equatorial Guinea	-2.81	-3.13	-0.32	155.	Sri Lanka	-5.31	-4.04	1.27
61.	Romania	-6.62	-6.94	-0.32	156.	Madagascar	-5.66	-4.30	1.36
62.	Qatar	-4.16	-4.47	-0.31	157.	Bhutan	-5.37	-4.00	1.37
63.	Tuvalu	-2.71	-3.01	-0.30	158.	Azerbaijan	-6.32	-4.92	1.40
64.	Switzerland	-2.28	-2.58	-0.29	159.	Maldives	-12.12	-10.71	1.41
65.	Jamaica	-2.65	-2.94	-0.29	160.	Mexico	-3.94	-2.51	1.42
66.	Palau	-2.54	-2.82	-0.28	161.	Italy	-3.42	-1.98	1.44
67.	Monaco	-2.18	-2.44	-0.27	162.	Chile	-1.46	0.00	1.46
68.	Lao	-4.18	-4.42	-0.24	163.	Argentina	-3.70	-2.24	1.47
69.	Micronesia, Fed. Sts.	-2.75	-2.94	-0.19	164.	France	-2.91	-1.40	1.51
70.	Libya	-5.19	-5.37	-0.19	165.	El Salvador	-6.30	-4.77	1.53
71.	Belarus	-7.86	-8.02	-0.16	166.	Latvia	-6.26	-4.58	1.68
72.	Pakistan	-2.10	-2.26	-0.16	167.	Austria	-3.65	-1.88	1.77
73.	Colombia	-2.86	-3.00	-0.15	168.	Syria	-4.36	-2.55	1.82
74.	Saudi Arabia	-7.64	-7.79	-0.14	169.	China	-8.74	-6.88	1.86
75.	India	-3.93	-4.07	-0.14	170.	Egypt	-6.91	-5.04	1.86
76.	Spain	-3.09	-3.22	-0.13	171.	Vietnam	-3.38	-1.25	2.13
77.	Grenada	-1.32	-1.42	-0.09	172.	Mongolia	-7.64	-5.50	2.14
78.	Turkmenistan	-3.20	-3.29	-0.09	173.	Oman	-3.81	-1.64	2.17
79.	Marshall Islands	-0.79	-0.87	-0.08	174.	Liberia	-7.98	-5.69	2.28
80.	Slovak Republic	-3.72	-3.79	-0.07	175.	Lebanon	-7.27	-4.97	2.30
81.	Myanmar	-3.36	-3.41	-0.05	176.	St. Kitts and Nevis	-6.17	-3.86	2.31
82.	Paraguay	-3.27	-3.29	-0.02	177.	Bulgaria	-5.62	-3.28	2.34
83.	Cameroon	-3.85	-3.84	0.01	178.	Turkey	-8.87	-6.43	2.44
84.	Malawi	-7.27	-7.24	0.03	179.	Rwanda	-11.01	-8.22	2.79
85.	Armenia	-4.95	-4.91	0.04	**180.**	**Malaysia**	**-1.86**	**0.97**	**2.83**
86.	Niger	-5.85	-5.81	0.04	181.	Serbia	-6.90	-3.98	2.93
87.	Jordan	-3.10	-3.05	0.05	182.	Botswana	-6.30	-3.06	3.25
88.	New Zealand	-2.08	-1.98	0.10	183.	North Korea	-6.03	-2.37	3.66
89.	Sudan	-3.10	-2.99	0.10	184.	Cambodia	-9.85	-5.68	4.17
90.	Nigeria	-3.51	-3.41	0.11	185.	Ireland	-6.96	-2.75	4.21
91.	Ecuador	-3.09	-2.98	0.11	186.	Singapore	-3.78	0.71	4.50
92.	Dominica	-1.80	-1.66	0.14	187.	Portugal	-7.76	-3.03	4.73
93.	Uzbekistan	-3.63	-3.49	0.14	188.	Greece	-6.34	-0.40	5.94
94.	United Arab Emirates	-2.37	-2.22	0.15	189.	Haiti	-2.74	10.24	12.99
95.	Belize	-2.44	-2.24	0.20					

neonatal deaths and the most vulnerable newborns and children. They are i) access to family planning, ii) delivery done by highly trained personnel, and iii) access to emergency obstetric care for complications. Most of these interventions are costly and thus, only countries with high income are able to afford such interventions and hence greatly reduce the mortality rate.

Children that die before 28 days of life often suffer from diseases and conditions that are readily preventable or treatable with proven, cost-effective interventions. Systematic action is required by governments and partners to reach women and babies with effective care. Highly cost-effective interventions are feasible even at the community level, and most can be linked with preventive and curative initiatives for mothers and babies. For example, early postnatal home visits are effective in promoting healthy behaviors such as breastfeeding and clean cord care and in reaching new mothers.

In **Fig.** 1, we can clearly see that most countries had a positive economic growth while at the same time manage to reduce the U5MR at a negative growth. In the first period (2003-2007, **Fig.** 1a), several countries with positive economic growth unfortunately have increased on their U5MR. Most of these countries were on their early phase of development. In the second period, we can see new countries like Malaysia and Singapore emerged on the top-right of the graph. Thus, the data raised serious concern on the health status of the countries.

Direct causes for U5MR in Malaysia

U5MR value for Malaysia, Greece, Portugal, Singapore, Ireland, and Cambodia are among countries that have high increment in U5MR ΔR value (**Table** 1 and **Fig.** 1). It indicates that healthy ecosystem in each countries are being endangered at some serious level that deviate the u5mr value from world-widely decreasing pattern.

Especially for Malaysia from 2000 to 2013, more than 80% of U5MR causes are diseases and infections, namely; congenital anomalies, prematurity, pneumonia, sepsis, birth asphyxia, and other communicable and non-communicable diseases. Based on WHO health statistic 2013, prior to year 2000, under-five mortality in Malaysia showed a declining trend with in average of -8.8% per annum, but then followed by an increasing trend with average of +1.8% per annum from 1999 to 2010 [13]. It is noteworthy that trend in stillbirths and neonatal deaths recorded in a retrospective observation from a representative hospital in Malaysia also shown an unpleasant increase from 5.4 and 5.1 in 2005 to 6.2 and 5.8 in 2010 for stillbirth and neonatal mortalities, respectively [14].

Congenital anomalies are the leading cause of under-five mortality and infant mortality in developed and developing countries. Child born with congenital anomalies usually associated with prematurity, lower birth weight and increased specialized care. While maternal factors include exposure to pollutant during early perinatal period, alcohol, tobacco, psychoactive substance, certain chemicals. Working or living near or in waste sites, smelters and mines may also be a risk factor.

Pneumonia, an infection of lower respiratory tracts also contributes to the cause of death in under-five children. Microbes that responsible for the disease includes measles, pertussis, pneumococcal and Heamophilus influenza Type B. WHO and UNICEF had outlined one of their child survival strategy by embracing the 3 key elements with one of it by protection against infection through hand hygiene, improve nutrition, breast feeding and avoidance of pollutants and improving access to health facilities.

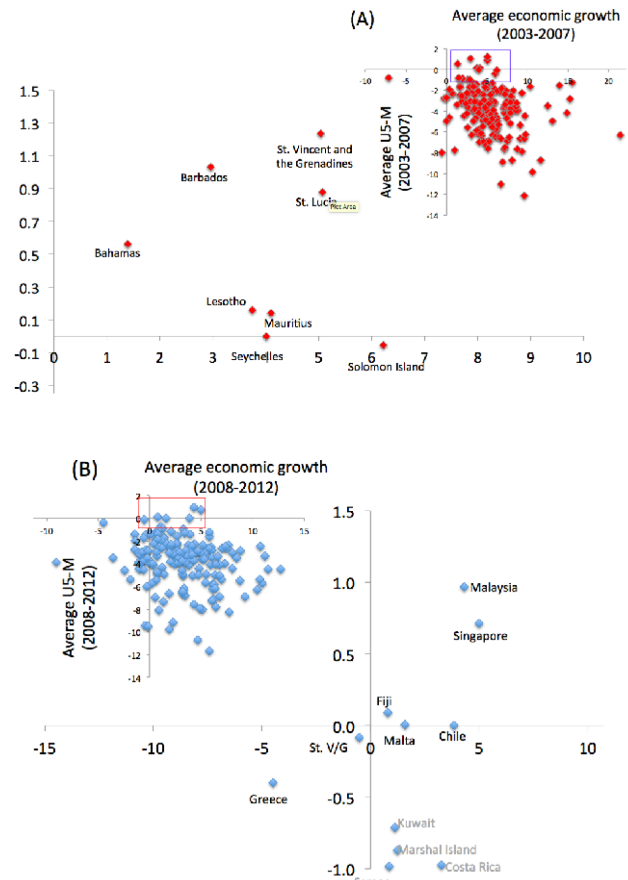

Fig. 1. Average economic growth in the period of 2003-2007 (A) and 2008-2012 (B) for various countries plotted with U5MR average growth data for the same period of years. Offsets are enlarged plots from small boxes in the graphs.

Pollutions as indirect causes for not reducing U5MR in Malaysia

We observed recorded river pollution data from 2006-2013, and analyzed the data to predict pollution contribution towards the increment of U5MR [15]. Statistical analysis result shows that river pollutions have strong correlation with modernizations and industrializations (**Fig.** 2), as the rivers are final outlet of industrial wastes [16]. While the national income increases each year, more rivers are being polluted. The river pollution effect upon urbanization may took about two years lag time as observed in **Fig.** 2 that reveal the most statistically significant correlation.

We noticed that recent increase in the number of bod-based class III and IV rivers have strong relationship (r_p = 0.924 and R^2

= 0.854) with the recent increment of Malaysia U5MR (**Fig.** 3). This was not observed when plotting the U5MR with other classifications that indicate river pollution such as the water quality index (WQI) that has been officially used by the DOE Malaysia. Physicochemical condition of rivers in developed country (e.g. Japan) has somewhat more satisfying condition in comparison to the developing countries [17]. This suggested an important indication on how the developed regions were accumulatively able to achieve their target on U5MR, while the developing regions were far behind their 2015 target [1].

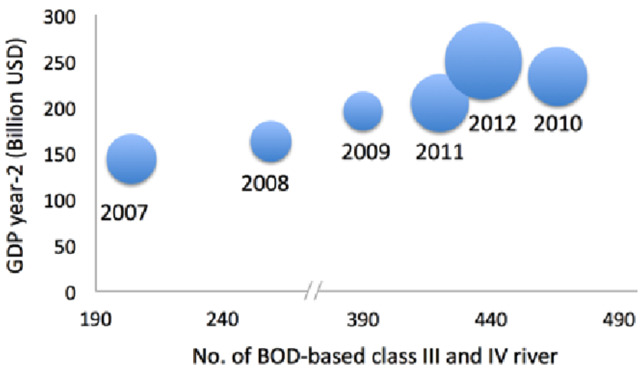

Fig. 2. Bubble plot of number of class III and IV rivers based on BOD measurement in the function of GDP value taken at two years prior to the BOD observation (year-2). Bubble size corresponds to heavy metal concentration in respective rivers.

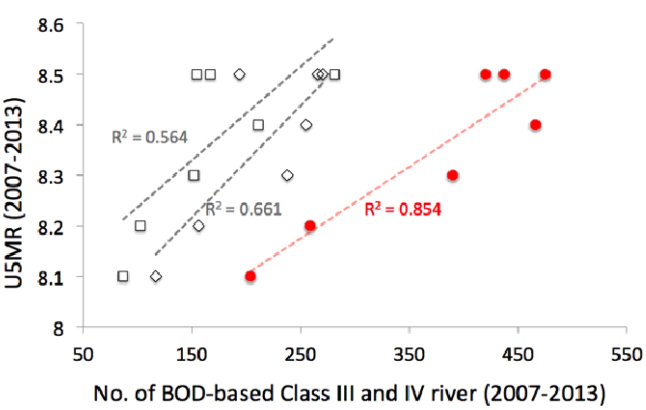

Fig. 3. Statistical relationship between number of class III and IV polluted rivers (filled circle) and U5MR. BOD-based class III and IV river data were taken from observatory under the supervision of the Department of Environment Malaysia. Number of class III alone (diamond) and class IV alone (square) were also evaluated.

Further, main sources of river pollutions that were identified by the DOE were namely, wastes from industrials, mines, and domestic households (sewage); natural wastes from usage of toxic chemicals, intermittent oil discharge; agricultural wastes that usually include pesticides and insecticides; surface and road drainage; and other miscellaneous wastes. Human then, uses river water directly or indirectly for consumption, industrial processes, fisheries, agricultural usage, recreation and many more. As a direct consequence from stream pollution, fish may injure or die. Indirectly, pollutant may be consumed by fish, enters and go up the food chain until it will be concentrated in human body.

For more than four decades the department of environment Malaysia (DOE) had been monitoring the Malaysian rivers and basins for river classification and also for prevention of potential biohazard. The rivers are classified into (I) – (V) classes, for (I) being the cleanest. They are monitored, measured and the data are calculated into a 0 to 100 index that incorporated biochemical oxygen demand (BOD), chemical oxygen demand (COD), dissolve oxygen (DO), ph, ammoniacal nitrogen (NH_3-N), and suspended solids (SS). Other factors like heavy metals concentration, planktons, diatoms, macroinvertebrates and fish sampling are not included in the water WQI.

There are approximately 500 rivers that are being constantly monitored by the DOE from over 1000 stations quarterly every year. From the formulated WQI, total polluted rivers (including the slightly polluted class III river) are decreasing from 10% of all monitored rivers in 2006, to about 5% in 2013. At a glance on **Fig.** 4, WQI data shows a decrease on number of polluted rivers. It may reflect to either environmental regulations are properly enforced, or civic concerns among the citizen are becoming higher. When we focus on BOD-based river classes, however, we found that the polluted (class III and IV) rivers are increasing from 21% (in 2006) to about 60% (in 2013) of the total monitored river. This is particularly important because oxygen demand has strong correlation to the dissolved pollutants [17].

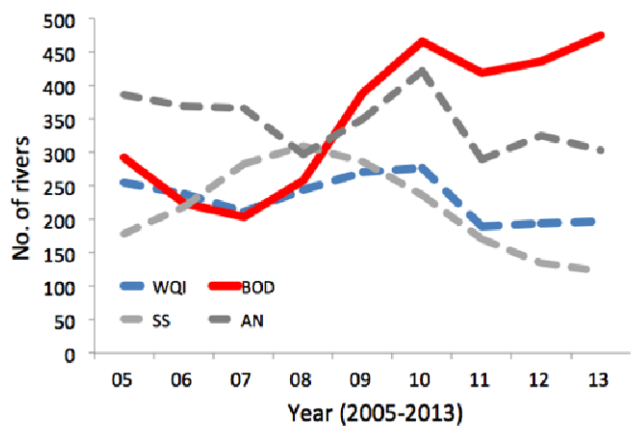

Fig. 4. Number of polluted river as reported by DOE Malaysia from 2005-2013 based on water quality index (WQI), biological oxygen demand (BOD), suspended solid (SS) and ammoniacal nitrogen (AN).

In 2012, over 1.5 million water pollution point sources were identified. The main point sources were manufacturing industries, sewage treatment plants, animal farm (pig farming), agro-based industries, wet markets, and food services establishments. Each year, at approximately 1000 tonnes/day of bod load is discharged into Malaysian water bodies. The growing number of BOD-based polluted river presumably caused by indiscriminate waste disposal from industrial and municipal sources, and inadequate treatment of water disposal. These resulted in an abundant presence of genotoxic pollutants in water, including many kinds of mutagenic and carcinogenic organics in the river. In Selangor River for example, chlorpyrifos, lindane, DDEs, heptachlor, endosulfan, diazinon, total DDTs, endosulfan sulfate and dieldrin were detected [18]. Various types of organochlorines (OC) and organophosphates were also detected from the surface water samples. It was also reported that majority of the rivers within the Peninsular Malaysia were contaminated with various degree of OC residues.

CONCLUSION

We re-examined contamination data acquired from the Department of Environment Malaysia, and map them with possible cause and effect, which are the GDP and U5MR, respectively. A nationwide study on river pollution and U5MR showed the child mortality was positively correlated with the number of biochemical oxygen demand (BOD)-based polluted river.

Nation development, health, and environmental concerns, are three components that have to grow in balance. Without proper understanding on consequences of imbalance ecosystem, 'one-directional' nation development, which conventionally based on GDP only would be a devastating situation for any country. Further, international analysts and political consultants have produced new indices for reference in order to worldwidely measure countries development aspects that were previously blinded by just looking at the GDP. Good country index, happy planet index, and social progress index are among many unique measurement tools that can be considered to have a more comprehensive overview upon countries development progress. Precaution steps such as mass education to raise awareness and practicing healthy culture are important to be absorbed in any community. In addition, early detection study on environmental pollutant at the point of care is urgently needed to support and ensure sustainability.

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