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*Supplement of*

## **Simulating the spread of disinfection by-products and anthropogenic bromoform emissions from ballast water discharge in Southeast Asia**

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Supplement Table: Modified world port ranking and ballast water volumes derived from both the biggest 100 cargo and container ports with respect to annual throughput in 2016 (AAPA, 2016). Ballast water volume was calculated as 33 % of total goods loaded in 2016, which amounts to 3.4 billion m<sup>3</sup> and is divided among all ports listed. CHBr<sub>3</sub> is calculated for each scenario as the annual amount discharged from ballast water for different shares of chemical BWTS installed (70 % for MODERATE, 50 % for LOW and 90 % for HIGH).

| PORT            | COUNTRY              | Latitude | Longitude | market volume | BW equivalent        | CHBr <sub>3</sub> amount in kmol/a |      |       |
|-----------------|----------------------|----------|-----------|---------------|----------------------|------------------------------------|------|-------|
|                 |                      |          |           | share in %    | in m <sup>3</sup> /a | MODERATE                           | LOW  | HIGH  |
| Shanghai        | China                | 31.230   | 121.474   | 5.11          | 173622371            | 108.7                              | 29.0 | 227.2 |
| Singapore       | Singapore            | 1.352    | 103.820   | 4.59          | 155770045            | 97.5                               | 26.0 | 203.8 |
| Guangzhou       | China                | 23.129   | 113.253   | 3.89          | 132210129            | 82.7                               | 22.1 | 173.0 |
| Ningbo          | China                | 29.868   | 121.544   | 3.54          | 120107924            | 75.2                               | 20.1 | 157.2 |
| Qingdao         | China                | 36.067   | 120.383   | 3.27          | 111095972            | 69.5                               | 18.6 | 145.4 |
| Rotterdam       | Netherlands          | 51.924   | 4.478     | 3.20          | 108668142            | 68.0                               | 18.1 | 142.2 |
| Tianjin         | China                | 39.084   | 117.201   | 3.06          | 103831507            | 65.0                               | 17.3 | 135.9 |
| Port Hedland    | Australia            | -20.312  | 118.575   | 2.95          | 100285267            | 62.8                               | 16.7 | 131.2 |
| Busan           | South Korea          | 35.180   | 129.076   | 2.74          | 92914291             | 58.1                               | 15.5 | 121.6 |
| Dalian          | China                | 38.914   | 121.615   | 2.25          | 76290834             | 47.7                               | 12.7 | 99.8  |
| Hong Kong       | China                | 22.396   | 114.109   | 2.19          | 74275073             | 46.5                               | 12.4 | 97.2  |
| Shenzhen        | China                | 22.543   | 114.063   | 1.91          | 64773732             | 40.5                               | 10.8 | 84.8  |
| Port Kelang     | Malaysia             | 3.005    | 101.409   | 1.85          | 62817843             | 39.3                               | 10.5 | 82.2  |
| Kwangyang       | South Korea          | 33.493   | 126.535   | 1.80          | 60997903             | 38.2                               | 10.2 | 79.8  |
| Xiamen          | China                | 24.480   | 118.089   | 1.73          | 58747979             | 36.8                               | 9.8  | 76.9  |
| Antwerp         | Belgium              | 51.219   | 4.402     | 1.62          | 55037257             | 34.4                               | 9.2  | 72.0  |
| Dubai Ports     | United Arab Emirates | 25.205   | 55.271    | 1.56          | 52796632             | 33.0                               | 8.8  | 69.1  |
| South Louisiana | United States        | 30.021   | -90.471   | 1.45          | 49177886             | 30.8                               | 8.2  | 64.4  |
| Houston         | United States        | 29.760   | -95.370   | 1.44          | 48893230             | 30.6                               | 8.2  | 64.0  |
| Nagoya          | Japan                | 35.181   | 136.906   | 1.26          | 42836935             | 26.8                               | 7.2  | 56.1  |
| Hamburg         | Germany              | 53.551   | 9.994     | 1.12          | 38100756             | 23.8                               | 6.4  | 49.9  |
| Itaqui          | Brazil               | -2.578   | -44.367   | 1.10          | 37239115             | 23.3                               | 6.2  | 48.7  |
| Qinhuangdao     | China                | 39.929   | 119.620   | 1.10          | 37186541             | 23.3                               | 6.2  | 48.7  |
| Ulsan           | South Korea          | 35.538   | 129.311   | 1.07          | 36297343             | 22.7                               | 6.1  | 47.5  |
| Inchon          | South Korea          | 37.456   | 126.705   | 1.07          | 36245605             | 22.7                               | 6.1  | 47.4  |

|                      |               |         |          |      |          |      |     |      |
|----------------------|---------------|---------|----------|------|----------|------|-----|------|
| Kaohsiung            | Taiwan        | 22.627  | 120.301  | 1.04 | 35302384 | 22.1 | 5.9 | 46.2 |
| Chiba                | Japan         | 35.607  | 140.106  | 1.04 | 35275262 | 22.1 | 5.9 | 46.2 |
| Tanjung Pelepas      | Malaysia      | 1.364   | 103.552  | 1.03 | 34876413 | 21.8 | 5.8 | 45.6 |
| Newcastle            | Australia     | -32.927 | 151.779  | 1.02 | 34723238 | 21.7 | 5.8 | 45.4 |
| Dampier              | Australia     | -20.664 | 116.708  | 1.02 | 34708749 | 21.7 | 5.8 | 45.4 |
| Saigon               | Viet Nam      | 10.750  | 106.742  | 0.98 | 33413647 | 20.9 | 5.6 | 43.7 |
| New York/New Jersey  | United States | 40.713  | -74.006  | 0.93 | 31718108 | 19.8 | 5.3 | 41.5 |
| Metro Vancouver      | Canada        | 49.197  | -123.182 | 0.92 | 31179303 | 19.5 | 5.2 | 40.8 |
| Tubarao              | Brazil        | -28.472 | -49.015  | 0.82 | 27693686 | 17.3 | 4.6 | 36.2 |
| Santos               | Brazil        | -23.968 | -46.329  | 0.81 | 27360136 | 17.1 | 4.6 | 35.8 |
| Algeciras - La Linea | Spain         | 36.141  | -5.456   | 0.74 | 25149429 | 15.7 | 4.2 | 32.9 |
| Gladstone            | Australia     | -23.852 | 151.264  | 0.73 | 24922393 | 15.6 | 4.2 | 32.6 |
| Laem Chabang         | Thailand      | 13.104  | 100.916  | 0.71 | 24144802 | 15.1 | 4.0 | 31.6 |
| Kobe                 | Japan         | 34.690  | 135.196  | 0.69 | 23337570 | 14.6 | 3.9 | 30.5 |
| Itaguai              | Brazil        | -22.863 | -43.778  | 0.69 | 23262183 | 14.6 | 3.9 | 30.4 |
| Pyeongtaek           | South Korea   | 36.983  | 126.841  | 0.68 | 23226582 | 14.5 | 3.9 | 30.4 |
| Tokyo                | Japan         | 35.689  | 139.692  | 0.66 | 22325564 | 14.0 | 3.7 | 29.2 |
| Hay Point            | Australia     | -21.306 | 149.292  | 0.65 | 22034361 | 13.8 | 3.7 | 28.8 |
| Long Beach           | United States | 33.770  | -118.194 | 0.64 | 21839071 | 13.7 | 3.6 | 28.6 |
| Bremen/Bremerhaven   | Germany       | 53.074  | 8.806    | 0.63 | 21445428 | 13.4 | 3.6 | 28.1 |
| Los Angeles          | United States | 34.052  | -118.244 | 0.62 | 21205994 | 13.3 | 3.5 | 27.8 |
| Richards Bay         | South Africa  | -28.781 | 32.038   | 0.61 | 20578650 | 12.9 | 3.4 | 26.9 |
| Kitakyushu           | Japan         | 33.883  | 130.875  | 0.60 | 20393401 | 12.8 | 3.4 | 26.7 |
| Valencia             | Spain         | 39.470  | -0.376   | 0.60 | 20266218 | 12.7 | 3.4 | 26.5 |
| Amsterdam Ports      | Netherlands   | 52.370  | 4.895    | 0.59 | 19877599 | 12.4 | 3.3 | 26.0 |
| Ust-Luga             | Russia        | 59.653  | 28.270   | 0.57 | 19324334 | 12.1 | 3.2 | 25.3 |
| Osaka                | Japan         | 34.694  | 135.502  | 0.56 | 19061373 | 11.9 | 3.2 | 24.9 |
| Colombo              | Sri Lanka     | 6.927   | 79.861   | 0.55 | 18724791 | 11.7 | 3.1 | 24.5 |
| Chittagong           | Bangladesh    | 22.348  | 91.812   | 0.54 | 18497631 | 11.6 | 3.1 | 24.2 |
| Paradip              | India         | 20.317  | 86.611   | 0.54 | 18411126 | 11.5 | 3.1 | 24.1 |

|                               |               |         |         |      |          |      |     |      |
|-------------------------------|---------------|---------|---------|------|----------|------|-----|------|
| Bandar Abbas                  | Iran          | 27.183  | 56.267  | 0.54 | 18388178 | 11.5 | 3.1 | 24.1 |
| Marseilles                    | France        | 43.296  | 5.370   | 0.53 | 18035493 | 11.3 | 3.0 | 23.6 |
| Daesan                        | South Korea   | 36.940  | 126.434 | 0.52 | 17777758 | 11.1 | 3.0 | 23.3 |
| Jawaharlal Nehru              | India         | 18.950  | 72.951  | 0.52 | 17664711 | 11.1 | 3.0 | 23.1 |
| Manila                        | Philippines   | 14.600  | 120.984 | 0.51 | 17363339 | 10.9 | 2.9 | 22.7 |
| Taichung                      | Taiwan        | 24.148  | 120.674 | 0.51 | 17256258 | 10.8 | 2.9 | 22.6 |
| New Orleans                   | United States | 29.951  | -90.072 | 0.50 | 16950597 | 10.6 | 2.8 | 22.2 |
| Le Havre                      | France        | 49.494  | 0.108   | 0.48 | 16263062 | 10.2 | 2.7 | 21.3 |
| Botas                         | Turkey        | 36.885  | 35.928  | 0.48 | 16236564 | 10.2 | 2.7 | 21.2 |
| Novorossisk                   | Russia        | 44.715  | 37.762  | 0.47 | 15962518 | 10.0 | 2.7 | 20.9 |
| Tanjung Priok                 | Indonesia     | -6.132  | 106.871 | 0.47 | 15945438 | 10.0 | 2.7 | 20.9 |
| Beaumont                      | United States | 30.080  | -94.127 | 0.47 | 15872245 | 9.9  | 2.7 | 20.8 |
| Jeddah                        | Saudi Arabia  | 21.285  | 39.238  | 0.46 | 15511232 | 9.7  | 2.6 | 20.3 |
| Corpus Christi                | United States | 27.801  | -97.396 | 0.45 | 15393982 | 9.6  | 2.6 | 20.1 |
| Yanbu                         | Saudi Arabia  | 24.023  | 38.190  | 0.41 | 13872405 | 8.7  | 2.3 | 18.2 |
| Saldanha Bay                  | South Africa  | -33.028 | 17.918  | 0.41 | 13769949 | 8.6  | 2.3 | 18.0 |
| Baton Rouge                   | United States | 30.458  | -91.140 | 0.40 | 13707294 | 8.6  | 2.3 | 17.9 |
| Jubail                        | Saudi Arabia  | 26.960  | 49.569  | 0.40 | 13681567 | 8.6  | 2.3 | 17.9 |
| Izmit (Kocaeli)               | Turkey        | 40.765  | 29.941  | 0.40 | 13660041 | 8.5  | 2.3 | 17.9 |
| Primorsk                      | Russia        | 46.723  | 36.354  | 0.39 | 13335285 | 8.3  | 2.2 | 17.5 |
| Bombay                        | India         | 19.076  | 72.878  | 0.38 | 13050063 | 8.2  | 2.2 | 17.1 |
| Virginia                      | United States | 36.912  | -76.324 | 0.38 | 12981932 | 8.1  | 2.2 | 17.0 |
| Karachi                       | Pakistan      | 24.861  | 67.010  | 0.38 | 12952244 | 8.1  | 2.2 | 16.9 |
| Visakhapatnam                 | India         | 17.702  | 83.290  | 0.37 | 12696329 | 7.9  | 2.1 | 16.6 |
| Alexandria and<br>El-Dekheila | Egypt         | 31.200  | 29.919  | 0.37 | 12677791 | 7.9  | 2.1 | 16.6 |
| Genoa                         | Italy         | 44.406  | 8.946   | 0.37 | 12615708 | 7.9  | 2.1 | 16.5 |
| Constantza                    | Romania       | 44.160  | 28.635  | 0.36 | 12299957 | 7.7  | 2.1 | 16.1 |
| Trieste                       | Italy         | 45.650  | 13.777  | 0.36 | 12261044 | 7.7  | 2.0 | 16.0 |
| Barcelona                     | Spain         | 41.385  | 2.173   | 0.36 | 12160392 | 7.6  | 2.0 | 15.9 |
| Chennai                       | India         | 13.084  | 80.290  | 0.36 | 12126121 | 7.6  | 2.0 | 15.9 |
| St. Petersburg                | Russia        | 59.934  | 30.335  | 0.35 | 11926082 | 7.5  | 2.0 | 15.6 |

|                               |                         |         |          |      |          |     |     |      |
|-------------------------------|-------------------------|---------|----------|------|----------|-----|-----|------|
| London                        | United Kingdom          | 51.507  | -0.128   | 0.35 | 11908807 | 7.5 | 2.0 | 15.6 |
| Grimsby and<br>Immingham      | United Kingdom          | 53.567  | -0.081   | 0.33 | 11260489 | 7.0 | 1.9 | 14.7 |
| Sines                         | Portugal                | 37.957  | -8.861   | 0.33 | 11230363 | 7.0 | 1.9 | 14.7 |
| Mobile                        | United States           | 30.695  | -88.040  | 0.32 | 10895508 | 6.8 | 1.8 | 14.3 |
| Philadelphia                  | United States           | 39.813  | -75.421  | 0.32 | 10856044 | 6.8 | 1.8 | 14.2 |
| Pohang                        | South Korea             | 36.019  | 129.343  | 0.32 | 10770560 | 6.7 | 1.8 | 14.1 |
| Plaquemines                   | United States           | 29.324  | -89.474  | 0.31 | 10661975 | 6.7 | 1.8 | 14.0 |
| Lake Charles                  | United States           | 30.227  | -93.217  | 0.31 | 10523999 | 6.6 | 1.8 | 13.8 |
| Calcutta                      | India                   | 22.573  | 88.364   | 0.31 | 10414136 | 6.5 | 1.7 | 13.6 |
| Aliaga                        | Turkey                  | 38.800  | 26.971   | 0.31 | 10376051 | 6.5 | 1.7 | 13.6 |
| Sao Sebastiao                 | Brazil                  | -23.806 | -45.402  | 0.29 | 9744753  | 6.1 | 1.6 | 12.8 |
| Dunkirk                       | France                  | 51.034  | 2.377    | 0.28 | 9632362  | 6.0 | 1.6 | 12.6 |
| Bintulu                       | Malaysia                | 3.171   | 113.042  | 0.28 | 9521005  | 6.0 | 1.6 | 12.5 |
| Calais                        | France                  | 50.951  | 1.859    | 0.27 | 9280698  | 5.8 | 1.5 | 12.1 |
| Khor Fakkan                   | United Arab<br>Emirates | 25.337  | 56.343   | 0.15 | 5230532  | 3.3 | 0.9 | 6.8  |
| Colon                         | Panama                  | 9.335   | -79.942  | 0.14 | 4593231  | 2.9 | 0.8 | 6.0  |
| Gioia Tauro                   | Italy                   | 38.426  | 15.899   | 0.12 | 4089343  | 2.6 | 0.7 | 5.4  |
| Piraeus                       | Greece                  | 37.943  | 23.647   | 0.12 | 3985329  | 2.5 | 0.7 | 5.2  |
| Savannah                      | United States           | 32.084  | -81.100  | 0.11 | 3887948  | 2.4 | 0.6 | 5.1  |
| Felixstowe                    | United Kingdom          | 51.962  | 1.351    | 0.11 | 3877662  | 2.4 | 0.6 | 5.1  |
| Northwest<br>Seaport Alliance | United States           | 47.606  | -122.332 | 0.11 | 3857258  | 2.4 | 0.6 | 5.0  |
| Mina Raysu                    | Oman                    | 16.970  | 53.981   | 0.10 | 3547086  | 2.2 | 0.6 | 4.6  |
| East Port Said<br>Port        | Egypt                   | 31.265  | 32.302   | 0.10 | 3417286  | 2.1 | 0.6 | 4.5  |
| Marsaxlokk                    | Malta                   | 35.840  | 14.545   | 0.10 | 3285001  | 2.1 | 0.5 | 4.3  |
| Tanger                        | Morocco                 | 35.759  | -5.834   | 0.09 | 3162276  | 2.0 | 0.5 | 4.1  |
| Keelung                       | Taiwan                  | 25.128  | 121.739  | 0.09 | 3057715  | 1.9 | 0.5 | 4.0  |

|              |                |         |          |      |         |     |     |     |
|--------------|----------------|---------|----------|------|---------|-----|-----|-----|
| Balboa       | Panama         | 8.961   | -79.563  | 0.09 | 3020852 | 1.9 | 0.5 | 4.0 |
| Yokohama     | Japan          | 35.444  | 139.638  | 0.09 | 2966353 | 1.9 | 0.5 | 3.9 |
| Ambarli      | Turkey         | 41.318  | 41.714   | 0.09 | 2965864 | 1.9 | 0.5 | 3.9 |
| Durban       | South Africa   | -29.859 | 31.022   | 0.08 | 2795024 | 1.7 | 0.5 | 3.7 |
| Melbourne    | Australia      | -37.814 | 144.963  | 0.08 | 2790294 | 1.7 | 0.5 | 3.7 |
| Manzanillo   | Mexico         | 20.333  | -77.120  | 0.08 | 2751068 | 1.7 | 0.5 | 3.6 |
| Dublin       | Ireland        | 53.350  | -6.260   | 0.08 | 2649232 | 1.7 | 0.4 | 3.5 |
| Southampton  | United Kingdom | 50.910  | -1.404   | 0.08 | 2623582 | 1.6 | 0.4 | 3.4 |
| Oakland      | United States  | 37.804  | -122.271 | 0.07 | 2527916 | 1.6 | 0.4 | 3.3 |
| Sydney Ports | Australia      | -33.853 | 151.210  | 0.07 | 2521384 | 1.6 | 0.4 | 3.3 |
| Cartagena    | Colombia       | 10.391  | -75.479  | 0.07 | 2454795 | 1.5 | 0.4 | 3.2 |
| Callao       | Peru           | -12.051 | -77.126  | 0.06 | 2192227 | 1.4 | 0.4 | 2.9 |
| Charleston   | United States  | 32.776  | -79.931  | 0.06 | 2129613 | 1.3 | 0.4 | 2.8 |
| Guayaquil    | Ecuador        | -2.171  | -79.922  | 0.06 | 1943327 | 1.2 | 0.3 | 2.5 |
| Dammam       | Saudi Arabia   | 26.393  | 49.978   | 0.06 | 1908603 | 1.2 | 0.3 | 2.5 |
| Kingston     | Jamaica        | 44.231  | -76.486  | 0.05 | 1672136 | 1.0 | 0.3 | 2.2 |
| Gdansk       | Poland         | 54.404  | 18.666   | 0.05 | 1663309 | 1.0 | 0.3 | 2.2 |
| Bangkok      | Thailand       | 13.756  | 100.502  | 0.05 | 1589441 | 1.0 | 0.3 | 2.1 |
| La Spezia    | Italy          | 44.102  | 9.824    | 0.05 | 1559103 | 1.0 | 0.3 | 2.0 |
| Montreal     | Canada         | 45.502  | -73.567  | 0.05 | 1544253 | 1.0 | 0.3 | 2.0 |
| Ashdod       | Israel         | 31.804  | 34.655   | 0.05 | 1539463 | 1.0 | 0.3 | 2.0 |
| Penang       | Malaysia       | 5.415   | 100.330  | 0.05 | 1533109 | 1.0 | 0.3 | 2.0 |
| Mersin       | Turkey         | 36.812  | 34.641   | 0.04 | 1500337 | 0.9 | 0.3 | 2.0 |
| Zeebrugge    | Belgium        | 51.319  | 3.207    | 0.04 | 1492773 | 0.9 | 0.2 | 2.0 |
| San Antonio  | Chile          | -33.593 | -71.608  | 0.04 | 1373664 | 0.9 | 0.2 | 1.8 |
| Haifa        | Israel         | 32.794  | 34.990   | 0.04 | 1352627 | 0.8 | 0.2 | 1.8 |
| San Juan     | Puerto Rico    | 18.466  | -66.106  | 0.04 | 1313309 | 0.8 | 0.2 | 1.7 |
| Honolulu     | United States  | 21.307  | -157.858 | 0.04 | 1292949 | 0.8 | 0.2 | 1.7 |
| Freeport     | Bahamas        | 26.542  | -78.646  | 0.04 | 1280151 | 0.8 | 0.2 | 1.7 |
| Brisbane     | Australia      | -27.471 | 153.023  | 0.04 | 1262858 | 0.8 | 0.2 | 1.7 |
| Limon-Moin   | Costa Rica     | 9.991   | -83.042  | 0.04 | 1256014 | 0.8 | 0.2 | 1.6 |
| Belawan      | Indonesia      | 3.784   | 98.694   | 0.04 | 1248633 | 0.8 | 0.2 | 1.6 |

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