# Supporting Information

**Material-specific properties applied to an environmental risk assessment of engineered nanomaterials – implications on grouping and read-across concepts**

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Table S1. Allocation of the applications to the nano-forms considered for nano-TiO2. All values are given as relative shares summing up to one.

|  |  |  |
| --- | --- | --- |
| **application** | **nano-TiO2** | **comment** |
|  | **anatase [-]** | **rutile[-]** |  |
| Paints | 0.089 |   |   |
| Plastic |   | 0.036 |   |
| Cosmetics |   | 0.594 |   |
| Coating | 0.019 | 0.019 | assumed 50/50 for both crystal forms |
| Batteries/Capacitors | 0.004 |   |   |
| Metals | 0.001 |   |   |
| Light bulbs | 0.002 |   |   |
| Glass&Ceramics | 0.017 |   |   |
| Filter | 0.058 |   |   |
| Consumer electronics | 0.069 |   |   |
| Textiles |   | 0.003 |   |
| Food |   | 0.004 |   |
| Ink |   |   |   |
| Cement | 0.001 |   |   |
| Cleaning agent |   | 0.061 |   |
| Spray | 0.002 |   |   |
| Paper |   | 0.000 |   |
| Sport goods |   | 0.015 |   |
| Wastewater treatment | 0.007 |   |   |
| **Total** | **0.269** | **0.732** |   |

Table S2. Allocation of the applications to the nano-forms considered for nano-Al2O3. All values are given as relative shares summing up to one.

|  |  |
| --- | --- |
| **application** | **nano-form** |
|   | **alpha-Al2O3** | **gamma-Al2O3** |
| Adhesive | 0.000003 |   |
| Automotive coating | 0.104148 |   |
| Catalyst |   | 0.002529 |
| Cement | 0.180767 |   |
| Ceramic material | 0.016281 |   |
| Cleaning agent | 0.102222 |   |
| Cosmetics | 0.090489 |   |
| Electronics | 0.000066 |   |
| Filter |   | 0.156909 |
| Health service |   | 0.000002 |
| Paint | 0.168698 |   |
| Plastic | 0.004938 |   |
| Polish | 0.062273 |   |
| Speciality paper | 0.106875 |   |
| Sporting good | 0.0038 |   |
| **Total** | **0.841** | **0.159** |

Table S3. Allocation of the applications to the nano-forms considered for multiwall carbon nanotubes (MWNTs) and single wall carbon nanotubes (SWNTs). All values are given as relative shares summing up to one.

|  |  |  |
| --- | --- | --- |
| **Application** | **MWNT-Share** | **SWNT Share** |
| Plastics | 0.84 |  |
| Paints | 0.01 |  |
| Textiles | 0.0002 |  |
| Automotive | 0.01 |  |
| Energy | 0.09 |  |
| Aerospace | 0.00625 |  |
| Electronics |  | 0.03 |
| Sensor |  | 0.004 |
| **Total** | **0.95645** | **0.034** |

Table S4. Ecotoxicological data that were used for the generation of the PSSD of nano-TiO2 in the fresh water compartment.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **author** | **year** | **anatase [%]** | **rutile [%]** | **duration [h]** | **taxonomic group** | **test organism** | **dose descriptor** | **concentration [µg/L]** | **AF short to long term effect** | **AF dose descriptor** |
| Amiano et al. 1 | 2012 | 86 | 14 | 48 | Crustacean | Daphnia magna | EC50 | 1200 | 10 | 10 |
| Amiano et al. 1 | 2012 | 86 | 14 | 48 | Crustacean | Daphnia magna | EC50 | 3400 | 10 | 10 |
| Amiano et al. 1 | 2012 | 86 | 14 | 48 | Crustacean | Daphnia magna | EC50 | 29700 | 10 | 10 |
| Amiano et al. 1 | 2012 | 86 | 14 | 48 | Crustacean | Daphnia magna | EC50 | 33600 | 10 | 10 |
| Angelstorf et al. 2 | 2014 | 86 | 14 | 96 | Invertebrate | Caenorhabditis elegans | NOEC | 3000 | 10 | 1 |
| Angelstorf et al. 2 | 2014 | 86 | 14 | 96 | Invertebrate | Caenorhabditis elegans | EC82 | 100000 | 10 | 10 |
| Aruoja et al.3 | 2015 | 12.4 | 87.6 | 72 | Algae | Raphidocelis subcapitata | EC50 | 1260 | 1 | 10 |
| Bar-Ilan et al. 4 | 2012 | 75 | 25 | 120 | Vertebrate | Danio Rerio | EC50 | 300000 | 10 | 10 |
| Bar-Ilan et al. 4 | 2012 | 75 | 25 | 120 | Vertebrate | Danio Rerio | EC50 | 1000000 | 10 | 10 |
| Barreto et al.5 | 2016 | 82 | 18 | 96 | Algae | Scenedesmus bijugus | EC20 | 9.6 | 1 | 2 |
| Bundschuh et al.6 | 2011 | 80 | 20 | 168 | Crustacean | Gammarus fossarum | LOEC | 200 | 10 | 2 |
| Chen et al.7 | 2011 | 75 | NA | 4320 | Vertebrate | Danio rerio | LOEC | 4000 | 1 | 2 |
| Cherchi et al.8 | 2011 | 100 | NA | 96 | Unicellular | Anabaena variabilis | EC50 | 620 | 1 | 10 |
| Clement et al. 9 | 2013 | 100 | 0 | 72 | Crustacean | Daphnia magna | EC50 | 1300 | 10 | 10 |
| Clement et al. 9 | 2013 | 100 | 0 | 72 | Crustacean | Daphnia magna | EC50 | 3150 | 10 | 10 |
| Clement et al. 9 | 2013 | 100 | 0 | 72 | Crustacean | Daphnia magna | EC50 | 3440 | 10 | 10 |
| Clemente et al. 10 | 2014 | 100 | 0 | 48 | Crustacean | Daphnia similis | EC50 | 750000 | 10 | 10 |
| Clemente et al. 10 | 2014 | 100 | 0 | 48 | Crustacean | Daphnia similis | EC50 | 1000000 | 10 | 10 |
| Clemente et al. 10 | 2014 | 80 | 20 | 48 | Crustacean | Daphnia similis | EC50 | 60160 | 10 | 10 |
| Clemente et al. 10 | 2014 | 80 | 20 | 48 | Crustacean | Daphnia similis | EC50 | 1000000 | 10 | 10 |
| Cupi et al.11 | 2016 | 0 | 100 | 48 | Crustacean | Daphnia magna | EC10 | 900 | 10 | 2 |
| Cupi et al.12 | 2015 | 0 | 100 | 48 | Crustacean | Daphnia magna | NOEC | 100000 | 10 | 1 |
| Cupi et al.12 | 2015 | 0 | 100 | 48 | Crustacean | Daphnia magna | NOEC | 100000 | 10 | 1 |
| Cupi et al. 11 | 2016 | 0 | 100 | 48 | Crustacean | Daphnia magna | HONEC | 100000 | 10 | 1 |
| Dabrunz et al. | 2011 | 100 | 0 | 96 | Crustacean | Daphnia magna | EC50 | 730 | 10 | 10 |
| Dalai et al. 13 | 2014 | 99.7 | NA | 48 | Crustacean | Ceriodaphnia dubia | NOEC | 4000 | 10 | 1 |
| Das et al. 14 | 2013 | 80 | 20 | 48 | Crustacean | Daphnia magna | NOEC | 4100 | 10 | 1 |
| Fang et al. 15 | 2015 | 100 | 0 | 96 | Vertebrate | Danio rerio | NOEC | 100000 | 10 | 1 |
| Fang et al. 15 | 2015 | 100 | 0 | 96 | Vertebrate | Danio rerio | HONEC | 500000 | 10 | 1 |
| Federici et al. 16 | 2007 | 25 | 75 | 336 | Vertebrate | Oncorhynchus mykiss | HONEC | 1000 | 10 | 1 |
| Fu et al.17 | 2015 | 99 | NA | 96 | Algae | Raphidocelis subcapitata | EC50 | 6300 | 1 | 10 |
| Fu et al. 17 | 2015 | 99 | NA | 96 | Algae | Raphidocelis subcapitata | EC50 | 8700 | 1 | 10 |
| George et al.18 | 2014 | 100 | 0 | 116 | Vertebrate | Danio rerio(embryos) | EC20 | 2500 | 10 | 2 |
| George et al. 18 | 2014 | 100 | 0 | 116 | Vertebrate | Danio rerio(embryos) | HONEC | 5000 | 10 | 1 |
| Gökce et al. 19 | 2018 | 90 | NA | 96 | Crustacean | Daphnia magna | LC50 | 1000 | 10 | 10 |
| Gomes et al. 20 | 2015 | 100 | 0 | 120 | Invertebrate | Enchytraeus crypticus | LOEC | 300 | 10 | 2 |
| Gomes et al. 20 | 2015 | 86 | 14 | 120 | Invertebrate | Enchytraeus crypticus | NOEC | 100000 | 10 | 1 |
| Gomes et al. 20 | 2015 | 100 | 0 | 120 | Invertebrate | Enchytraeus crypticus | NOEC | 100000 | 10 | 1 |
| Gomes et al. 20 | 2015 | 100 | 0 | 120 | Invertebrate | Enchytraeus crypticus | NOEC | 100000 | 10 | 1 |
| Gomes et al. 20 | 2015 | 100 | 0 | 120 | Invertebrate | Enchytraeus crypticus | NOEC | 100000 | 10 | 1 |
| Gunawan et al. 21 | 2013 | 100 | 0 | 192 | Algae | Chlamydomonas reinhardtii | HONEC | 100000 | 1 | 1 |
| Hall et al. 22 | 2009 | 100 | 0 | 48 | Crustacean | Ceriodaphnia dubia | LC50 | 7600 | 10 | 10 |
| Hall et al. 22 | 2009 | 100 | 0 | 168 | Crustacean | Ceriodaphnia dubia | IC25 | 8500 | 10 | 5 |
| Hall et al. 22 | 2009 | 100 | 0 | 48 | Crustacean | Ceriodaphnia dubia | LC50 | 57600 | 10 | 10 |
| Hall et al. 22 | 2009 | 100 | 0 | 48 | Crustacean | Daphnia pulex | LC50 | 9200 | 10 | 10 |
| Hall et al. 22 | 2009 | 100 | 0 | 168 | Vertebrate | Pimephales promelas | IC25 | 452000 | 10 | 5 |
| Hall et al. 22 | 2009 | 100 | 0 | 48 | Vertebrate | Pimephales promelas | LC50 | 500000 | 10 | 10 |
| Hall et al. 22 | 2009 | 100 | 0 | 96 | Algae | Raphidocelis subcapitata | IC25 | 1500 | 1 | 5 |
| Hartmann et al. 23 | 2010 | 67.2 | 32.8 | 72 | Algae | Raphidocelis subcapitata | EC10 | 3300 | 1 | 2 |
| Hartmann et al. 23 | 2010 | 72.6 | 18.4 | 72 | Algae | Raphidocelis subcapitata | EC10 | 15500 | 1 | 2 |
| Hartmann et al. 23 | 2010 | 100 | 0 | 72 | Algae | Raphidocelis subcapitata | EC10 | 18000 | 1 | 2 |
| Hund-Rinke et al. 24 | 2006 | 75 | NA | 72 | Algae | Desmodesmus subspicatus | EC50 | 44000 | 1 | 10 |
| Hund-Rinke et al. 24 | 2006 | 100 | 0 | 72 | Algae | Desmodesmus subspicatus | HONEC | 50000 | 1 | 1 |
| Hurel et al. 25 | 2018 | 0 | 100 | 72 | Crustacean | Daphnia magna | EC50 | 303000 | 10 | 10 |
| Iswarya et al.26 | 2015 | 100 | 0 | 72 | Algae | Chlorella sp | EC10 | 53 | 1 | 2 |
| Iswarya et al. 26 | 2015 | 0 | 100 | 72 | Algae | Chlorella sp | EC10 | 67 | 1 | 2 |
| Iswarya et al.27 | 2016 | 100 | 0 | 48 | Crustacean | Ceriodaphnia dubia | LC50 | 22560 | 10 | 10 |
| Iswarya et al. 27 | 2016 | 0 | 100 | 48 | Crustacean | Ceriodaphnia dubia | LC50 | 23760 | 10 | 10 |
| Iswarya et al. 27 | 2016 | 100 | 0 | 48 | Crustacean | Ceriodaphnia dubia | LC50 | 37040 | 10 | 10 |
| Iswarya et al. 27 | 2016 | 0 | 100 | 48 | Crustacean | Ceriodaphnia dubia | LC50 | 48000 | 10 | 10 |
| Jacobasch et al. 28 | 2014 | 86 | 14 | 504 | Crustacean | Daphnia magna | EC10 | 4520 | 1 | 2 |
| Ji et al. 29 | 2011 | 100 | 0 | 144 | Algae | Chlorella sp | NOEC | 16000 | 1 | 1 |
| Jovanovic et al. 30 | 2011 | 100 | 0 | 168 | Vertebrate | Pimephales promelas | HONEC | 1000000 | 10 | 1 |
| Kim et al. 31 | 2014 | 76.9 | 23.1 | 504 | Crustacean | Daphnia magna | NOEC | 1000 | 1 | 1 |
| Kim et al. 31 | 2010 | 76.9 | 23.1 | 504 | Crustacean | Daphnia magna | LOEC | 500 | 1 | 2 |
| Li, C. et al. 32 | 2012 | 100 | 0 | 48 | Unicellular | Paramecium multimicronucleatum | LC50 | 7215200 | 1 | 10 |
| Li, S. et al. 33 | 2016 | 86 | 14 | 48 | Crustacean | Daphnia magna | LC50 | 260 | 10 | 10 |
| Li, S. et al. 33 | 2016 | 86 | 14 | 48 | Crustacean | Daphnia magna | LC50 | 1030 | 10 | 10 |
| Li, S. et al. 33 | 2016 | 86 | 14 | 48 | Vertebrate | Oryzias latipes | LC50 | 26300 | 10 | 10 |
| Li, S. et al. 33 | 2016 | 86 | 14 | 48 | Vertebrate | Oryzias latipes | LC50 | 39900 | 10 | 10 |
| Li, S. et al. 33 | 2016 | 86 | 14 | 48 | Vertebrate | Oryzias latipes | LC50 | 250000 | 10 | 10 |
| Li, S. et al. 33 | 2016 | 86 | 14 | 48 | Vertebrate | Oryzias latipes | LC50 | 250000 | 10 | 10 |
| Li, S. et al. 33 | 2016 | 86 | 14 | 48 | Crustacean | Daphnia magna | LC50 | 250000 | 10 | 10 |
| Li, S. et al. 33 | 2016 | 86 | 14 | 48 | Crustacean | Daphnia magna | LC50 | 250000 | 10 | 10 |
| Li, S. et al.34 | 2014 | 86 | 14 | 48 | Crustacean | Daphnia magna | LC50 | 60 | 10 | 10 |
| Li, S. et al. 34 | 2014 | 86 | 14 | 48 | Vertebrate | Oryzias latipes | LC50 | 8500 | 10 | 10 |
| Li, S. et al. 34 | 2014 | 86 | 14 | 48 | Vertebrate | Oryzias latipes | LC50 | 500000 | 10 | 10 |
| Li, S. et al. 34 | 2014 | 86 | 14 | 48 | Crustacean | Daphnia magna | LC50 | 118000 | 10 | 10 |
| Li, S. et al. 35 | 2014 | 86 | 14 | 48 | Crustacean | Hyalella azteca | LC50 | 20000 | 10 | 10 |
| Li, S. et al. 35 | 2014 | 86 | 14 | 48 | Invertebrate | Lumbriculus variegatus | LC50 | 20000 | 10 | 10 |
| Li, Wallis et al.36 | 2014 | 86 | 14 | 96 | Crustacean | Hyalella azteca | LC50 | 29900 | 10 | 10 |
| Li, Wallis et al. 36 | 2014 | 86 | 14 | 96 | Crustacean | Hyalella azteca | LC50 | 631000 | 10 | 10 |
| Lu et al.37 | 2017 | 80 | 20 | 48 | Crustacean | Daphnia magna | EC50 | 3580 | 10 | 10 |
| Lu et al. 37 | 2017 | 50 | 50 | 48 | Crustacean | Daphnia magna | EC50 | 5150 | 10 | 10 |
| Lu et al. 37 | 2017 | 100 | 0 | 48 | Crustacean | Daphnia magna | EC50 | 6830 | 10 | 10 |
| Lu et al. 37 | 2017 | 80 | 20 | 48 | Crustacean | Daphnia magna | EC50 | 27450 | 10 | 10 |
| Lu et al. 37 | 2017 | 0 | 100 | 48 | Crustacean | Daphnia magna | EC50 | 31250 | 10 | 10 |
| Lu et al. 37 | 2017 | 100 | 0 | 48 | Crustacean | Daphnia magna | HONEC | 100000 | 10 | 1 |
| Lu et al. 37 | 2017 | 50 | 50 | 48 | Crustacean | Daphnia magna | HONEC | 100000 | 10 | 1 |
| Lu et al. 37 | 2017 | 0 | 100 | 48 | Crustacean | Daphnia magna | HONEC | 100000 | 10 | 1 |
| Lu et al. 37 | 2017 | 80 | 20 | 48 | Crustacean | Daphnia magna | HONEC | 100000 | 10 | 1 |
| Lu et al. 37 | 2017 | 80 | 20 | 48 | Crustacean | Daphnia magna | HONEC | 100000 | 10 | 1 |
| Ma et al. 38 | 2012 | 86 | 14 | 48 | Crustacean | Daphnia magna | LC50 | 29.8 | 10 | 10 |
| Ma et al. 38 | 2012 | 86 | 14 | 96 | Vertebrate | Oryzias latipes | LC50 | 2460 | 10 | 10 |
| Ma et al. 38 | 2012 | 86 | 14 | 96 | Vertebrate | Oryzias latipes | LC50 | 294000 | 10 | 10 |
| Ma et al. 38 | 2012 | 86 | 14 | 48 | Crustacean | Daphnia magna | NOEC | 100000 | 10 | 1 |
| Mansfield et al.39 | 2015 | 99 | 1 | 8 | Crustacean | Daphnia magna | LC50 | 139 | 10 | 10 |
| Mansfield et al. 39 | 2015 | 99 | 1 | 8 | Crustacean | Daphnia magna | LC50 | 778 | 10 | 10 |
| Mansfield et al. 39 | 2015 | 99 | 1 | 8 | Crustacean | Daphnia magna | NOEC | 20000 | 10 | 1 |
| Marcone et al. 40 | 2012 | 70 | 30 | 48 | Invertebrate | Daphnia similis | EC50 | 7800 | 10 | 10 |
| Marcone et al. 40 | 2012 | 70 | 30 | 48 | Invertebrate | Daphnia similis | EC50 | 12500 | 10 | 10 |
| Marcone et al. 40 | 2012 | 70 | 30 | 48 | Invertebrate | Daphnia similis | HONEC | 100000 | 10 | 1 |
| Marcone et al. 40 | 2012 | 100 | 0 | 48 | Invertebrate | Daphnia similis | EC50 | 56900 | 10 | 10 |
| Marcone et al. 40 | 2012 | 0 | 100 | 48 | Invertebrate | Daphnia similis | HONEC | 100000 | 10 | 1 |
| Marcone et al. 40 | 2012 | 0 | 100 | 48 | Invertebrate | Daphnia similis | HONEC | 100000 | 10 | 1 |
| Metzler et al.41 | 2011 | 80-90 | 10 to 20 | 96 | Algae | Raphidocelis subcapitata | EC50 | 113000 | 1 | 10 |
| Nicolas et al.42 | 2016 | 98.5 | NA | 72 | Algae | Raphidocelis subcapitata | EC50 | 2700 | 1 | 10 |
| Nicolas et al. 42 | 2016 | ? | 89 | 72 | Algae | Raphidocelis subcapitata | NOEC | 4700 | 1 | 1 |
| Nicolas et al. 42 | 2016 | 98.5 | NA | 72 | Algae | Raphidocelis subcapitata | EC50 | 8500 | 1 | 10 |
| Nicolas et al. 42 | 2016 | ? | 89 | 72 | Algae | Raphidocelis subcapitata | EC50 | 39000 | 1 | 10 |
| Nicolas et al. 42 | 2016 | 98.5 | NA | 72 | Algae | Raphidocelis subcapitata | EC50 | 50000 | 1 | 10 |
| Nicolas et al. 42 | 2016 | ? | 89 | 72 | Algae | Raphidocelis subcapitata | EC50 | 50000 | 1 | 10 |
| Oleszczuk et al.43 | 2015 | 75 | NA | 48 | Crustacean | Daphnia magna | EC50 | 99000 | 10 | 10 |
| Ozkaleli et al.44 | 2018 | 100 | 0 | 72 | Algae | Raphidocelis subcapitata | EC50 | 4160 | 1 | 10 |
| Ozkaleli et al. 44 | 2018 | 100 | 0 | 72 | Algae | Raphidocelis subcapitata | EC50 | 3580 | 1 | 10 |
| Ozkaleli et al. 44 | 2018 | 100 | 0 | 72 | Algae | Raphidocelis subcapitata | EC50 | 9320 | 1 | 10 |
| Ozkaleli et al. 44 | 2018 | 100 | 0 | 72 | Algae | Raphidocelis subcapitata | EC50 | 12140 | 1 | 10 |
| Picado et al.45 | 2015 | 65 | 35 | 48 | Crustacean | Daphnia magna | NOEC | 5600 | 10 | 1 |
| Picado et al. 45 | 2015 | 65 | 35 | 504 | Vertebrate | Carassius auratus | HONEC | 100000 | 1 | 1 |
| Picado et al. 45 | 2015 | 65 | 35 | 168 | plant | Lemna minor | HONEC | 90000 | 1 | 1 |
| Rocco et al.46 | 2015 | 25 | 75 | 28d | Vertebrate | Danio rerio | HONEC | 10 | 1 | 1 |
| Rocheleau et al.47 | 2015 | 100 | 0 | 24 | invertebrate | Caenorhabditis elegans | HONEC | 500000 | 10 | 1 |
| Rocheleau et al. 47 | 2015 | 100 | 0 | 24 | invertebrate | Caenorhabditis elegans | HONEC | 500000 | 10 | 1 |
| Rocheleau et al. 47 | 2015 | 100 | 0 | 24 | invertebrate | Caenorhabditis elegans | HONEC | 500000 | 10 | 1 |
| Rocheleau et al. 47 | 2015 | 0 | 100 | 24 | invertebrate | Caenorhabditis elegans | HONEC | 500000 | 10 | 1 |
| Rocheleau et al. 47 | 2015 | 0 | 100 | 24 | invertebrate | Caenorhabditis elegans | HONEC | 500000 | 10 | 1 |
| Rocheleau et al. 47 | 2015 | 100 | 0 | 24 | invertebrate | Caenorhabditis elegans | HONEC | 500000 | 10 | 1 |
| Rocheleau et al. 47 | 2015 | 83 | 17 | 24 | invertebrate | Caenorhabditis elegans | HONEC | 500000 | 10 | 1 |
| Roy et al.48 | 2016 | 81.1 | 18.9 | 72 | Algae | Chlorella sp. | EC50 | 1565 | 1 | 10 |
| Roy et al. 48 | 2016 | 81.1 | 18.9 | 72 | Algae | Chlorella sp. | EC50 | 2160 | 1 | 10 |
| Roy et al. 48 | 2016 | 81.1 | 18.9 | 72 | Algae | Scenedesmus subspicatus  | EC50 | 2752 | 1 | 10 |
| Roy et al. 48 | 2016 | 81.1 | 18.9 | 72 | Algae | Scenedesmus subspicatus  | EC50 | 4139 | 1 | 10 |
| Roy et al. 48 | 2016 | 81.1 | 18.9 | 72 | Algae | Chlorella sp | EC50 | 5956 | 1 | 10 |
| Roy et al. 48 | 2016 | 81.1 | 18.9 | 72 | Algae | Scenedesmus subspicatus  | EC50 | 7632 | 1 | 10 |
| Sadiq et al. 49 | 2011 | 75 | NA | 72 | Algae | Chlorella sp. | NOEC | 890 | 1 | 1 |
| Sadiq et al. 49 | 2011 | 75 | NA | 72 | Algae | Scenedesmus subspicatus  | NOEC | 1200 | 1 | 1 |
| Salieri et al.50 | 2015 | 96 | 4 | 96 | Crustacean | Daphnia magna | EC50 | 32000 | 10 | 10 |
| Salieri et al. 50 | 2015 | 96 | 4 | 96 | Crustacean | Daphnia magna | EC50 | 33000 | 10 | 10 |
| Salieri et al. 50 | 2015 | 96 | 4 | 96 | Crustacean | Daphnia magna | EC50 | 82000 | 10 | 10 |
| Seitz et al.51 | 2016 | 70 | 30 | 96 | Crustacean | Daphnia magna | EC50 | 2980 | 10 | 10 |
| Seitz et al. 51 | 2016 | 100 | 0 | 96 | Crustacean | Daphnia magna | EC50 | 850 | 10 | 10 |
| Sendra et al.52 | 2018 | 79 | 21 | 72 | Algae | Chlamydomonas reinhardtii | EC50 | 2300 | 1 | 10 |
| Sendra et al. 52 | 2018 | 79 | 21 | 72 | Algae | Chlamydomonas reinhardtii | EC50 | 551700 | 1 | 10 |
| Wang, Hu et al. 53 | 2011 | 100 | 0 | 96 | Crustacean | Ceriodaphnia dubia | NOEC | 400000 | 10 | 1 |
| Wang et al. 54 | 2009 | 100 | 0 | 24 | Invertebrate | Caenorhabditis elegans | LC50 | 79900 | 10 | 10 |
| Wang et al. 55 | 2008 | 86 | 14 | 120 | Algae | Chlamydomonas reinhardtii | NOEC | 1000 | 1 | 1 |
| Warheit et al. 56 | 2007 | 21 | 79 | 48 | Crustacean | Daphnia magna | HONEC | 100000 | 10 | 1 |
| Warheit et al. 56 | 2007 | 21 | 79 | 72 | Algae | Raphidocelis subcapitata | EC50 | 21000 | 1 | 10 |
| Warheit et al. 56 | 2007 | 21 | 79 | 96 | Vertebrate | Oncorhynchus mykiss | HONEC | 100000 | 10 | 1 |
| Wiench et al. 57 | 2009 | 0 | 100 | 504 | Crustacean | Daphnia magna | NOEC | 3000 | 1 | 1 |
| Wormington et al.58 | 2016 | 100 | 0 | 48 | Crustacean | Daphnia magna | LC50 | 840 | 10 | 10 |
| Wormington et al.58 | 2016 | 100 | 0 | 48 | Crustacean | Daphnia magna | LOEC | 1500 | 10 | 2 |
| Wormington et al. 58 | 2016 | 100 | 0 | 48 | Crustacean | Daphnia magna | NOEC | 2000 | 10 | 1 |
| Wyrwoll et al.59 | 2016 | 100 | 0 | 48 | Crustacean | Daphnia magna | EC50 | 530 | 10 | 10 |
| Wyrwoll et al. 59 | 2016 | 100 | 0 | 48 | Crustacean | Daphnia magna | EC50 | 1100 | 10 | 10 |
| Wyrwoll et al. 59 | 2016 | 100 | 0 | 48 | Crustacean | Daphnia magna | EC50 | 1280 | 10 | 10 |
| Wyrwoll et al. 59 | 2016 | 100 | 0 | 48 | Crustacean | Daphnia magna | EC50 | 2900 | 10 | 10 |
| Wyrwoll et al. 59 | 2016 | 100 | 0 | 48 | Crustacean | Daphnia magna | EC50 | 3880 | 10 | 10 |
| Wyrwoll et al. 59 | 2016 | 100 | 0 | 48 | Crustacean | Daphnia magna | EC50 | 79520 | 10 | 10 |
| Xiong et al. 60 | 2011 | 100 | 0 | 96 | Vertebrate | Danio Rerio | LC50 | 124500 | 10 | 10 |
| Yang et al. 61 | 2013 | 75 | 25 | 24 | Vertebrate | Danio Rerio | LC50 | 156000 | 10 | 10 |
| Yang et al. 61 | 2013 | 75 | 25 | 24 | Vertebrate | Danio Rerio | LC50 | 290000 | 10 | 10 |
| Yu et al.62 | 2018 | 100 | 0 | 96 | Algae | Chlamydomonas reinhardtii | EC50 | 359822 | 1 | 10 |
| Zhu, Chang et al. 63 | 2010 | 80 | 20 | 72 | Crustacean | Daphnia magna | EC13 | 100 | 10 | 2 |
| Zhu, Chang et al. 63 | 2010 | 80 | 20 | 504 | Crustacean | Daphnia magna | EC50 | 460 | 1 | 10 |
| Zhu, Zhu et al. 64 | 2008 | 100 | 0 | 48 | Crustacean | Daphnia magna | EC50 | 35306 | 10 | 10 |

Legend: ECx = effective concentration at which a response of 'x' percent is observed; ICx = Inhibitory concentration at which an inhibition of 'x' percent is observed regarding a specific biological function.; LCx: lethal concentration that is expected to cause death to x% of the population. LOEC = lowest observed effect concentration; NOEC= no observed effect concentration; HONEC = highest observed no effect concentration.

Table S5. Ecotoxicological data that were used for the generation of the PSSD of nano-Al2O3 in the fresh water compartment.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **author** | **year** | **crystal form** | **test organism** | **taxonomic****group** | **duration [h]** | **dose descriptor** | **concentration[µg/L]** | **AF acute to** **chronic** | **AF dose descriptor** |
| Hu et al.65 | 2012 | gamma | Ceriodaphnia dubia | Crustacea | 48 | NOEC | 150000 | 10 | 1 |
| Li et al. 32 | 2012 | alpha | Paramecium multimicronucleatum | unicellular | 48h | LC50 | 9269200 | 1'000\* |
| Li, Minghua et al. 66 | 2011 | gamma | Ceriodaphnia dubia | Crustacea | 168 | EC50 | 45000 | 10 | 10 |
| Pakrashi et al.67 | 2013 | gamma | Ceriodaphnia dubia | Crustacea | 72h | LC50 | 74300 | 10 | 10 |
| Stanley et al.68 | 2010 | gamma | Hyalella azteca | Crustacea | 240 | NOEC | 100000 | 10 | 1 |
| Stanley et al. 68 | 2010 | gamma | Tubifex tubifex | Invertebrate | 240 | NOEC | 100000 | 10 | 1 |
| Svartz et al. 69 | 2017 | gamma | Rhinella arenarum | Vertebrate | 504 | LC50 | 10500 | 1 | 10 |
| Wang et al. 54 | 2009 | gamma | Ceriodaphnia dubia | Crustacea | 48 | LC50 | 610000 | 10 | 10 |

\*Please note: For alpha Al2O3 was only one data point reported, the standard AF of 1000 was applied to convert the LC50 into a predicted no-effect concentration(cf. Echa 200870

Legend: ECx = effective concentration at which a response of 'x' percent is observed; ICx = Inhibitory concentration at which an inhibition of 'x' percent is observed regarding a specific biological function.; LCx: lethal concentration that is expected to cause death to x% of the population; NOEC= no observed effect concentration

Table S6: Ecotoxicological data that were used for the generation of the PSSD of multi-wall and single-wall carbon nanotubes in the fresh water compartment.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **authors** | **year** | **nano-form** | **dose descriptor** | **Tįtest organsim** | **taxonomic group** | **concentration [µg/l]**  | **exposure time [h]** | **AF time** | **AF no-effect** |
| Mouchet et al.71 | 2008 | DWNT | HONEC | Ambystoma mexicanum | vertebrate | 100'000.0 | 288 | 10 | 1 |
| Alloy et al.72 | 2011 | MWNT | LOEC | Ceriodaphnia dubia | crustacea | 2'380.0 | 168 | 10 | 2 |
| Kennedy et al.73 | 2008 | MWNT | EC50 | Ceriodaphnia dubia | crustacea | 50'900.0 | 48 | 10 | 10 |
| Li et al.74 | 2011 | MWNT | LC50  | Ceriodaphnia dubia | crustacea | 8'000.0 | 24 | 10 | 10 |
| Long et al.75 | 2012 | MWNT | IC50 | Chlorella sp. | algae | 8'400.0 | 96 | 1 | 10 |
| Long et al. 75 | 2012 | MWNT | IC50 | Chlorella sp. | algae | 11'300.0 | 96 | 1 | 10 |
| Long et al. 75 | 2012 | MWNT | IC50 | Chlorella sp. | algae | 11'500.0 | 96 | 1 | 10 |
| Long et al. 75 | 2012 | MWNT | IC50 | Chlorella sp. | algae | 12'400.0 | 96 | 1 | 10 |
| Long et al. 75 | 2012 | MWNT | IC50 | Chlorella sp. | algae | 12'400.0 | 96 | 1 | 10 |
| Long et al. 75 | 2012 | MWNT | IC50 | Chlorella sp. | algae | 12'700.0 | 96 | 1 | 10 |
| Long et al. 75 | 2012 | MWNT | IC50 | Chlorella sp. | algae | 13'900.0 | 96 | 1 | 10 |
| Long et al. 75 | 2012 | MWNT | IC50 | Chlorella sp. | algae | 36'200.0 | 96 | 1 | 10 |
| Long et al. 75 | 2012 | MWNT | IC50 | Chlorella sp. | algae | 36'800.0 | 96 | 1 | 10 |
| Long et al. 75 | 2012 | MWNT | IC50 | Chlorella sp. | algae | 38'800.0 | 96 | 1 | 10 |
| Long et al. 75 | 2012 | MWNT | IC50 | Chlorella sp. | algae | 39'600.0 | 96 | 1 | 10 |
| Long et al. 75 | 2012 | MWNT | IC50 | Chlorella sp. | algae | 41'000.0 | 96 | 1 | 10 |
| Long et al. 75 | 2012 | MWNT | IC50 | Chlorella sp. | algae | 41'400.0 | 96 | 1 | 10 |
| Long et al. 75 | 2012 | MWNT | IC50 | Chlorella sp. | algae | 45'800.0 | 96 | 1 | 10 |
| Long et al. 75 | 2012 | MWNT | IC50 | Chlorella sp. | algae | 46'300.0 | 96 | 1 | 10 |
| Long et al. 75 | 2012 | MWNT | IC50 | Chlorella sp. | algae | 47'300.0 | 96 | 1 | 10 |
| Long et al. 75 | 2012 | MWNT | IC50 | Chlorella sp. | algae | 62'800.0 | 96 | 1 | 10 |
| Long et al. 75 | 2012 | MWNT | IC50 | Chlorella sp. | algae | 74'500.0 | 96 | 1 | 10 |
| Long et al. 75 | 2012 | MWNT | IC50 | Chlorella sp. | algae | 75'200.0 | 96 | 1 | 10 |
| Schwab et al.76 | 2011 | MWNT | NOEC | Chlorella vulgaris | algae | 42.0 | 96 | 1 | 1 |
| Schwab et al. 76 | 2011 | MWNT | NOEC  | Chlorella vulgaris | algae | 180.0 | 96 | 1 | 1 |
| Schwab et al. 76 | 2011 | MWNT | NOEC | Chlorella vulgaris | algae | 1'000.0 | 96 | 1 | 1 |
| Schwab et al. 76 | 2011 | MWNT | NOEC | Chlorella vulgaris | algae | 3'000.0 | 96 | 1 | 1 |
| Schwab et al. 76 | 2011 | MWNT | NOEC | Chlorella vulgaris | algae | 3'000.0 | 96 | 1 | 1 |
| Sohn et al.77 | 2015 | SWNT | EC50 | Chlorella vulgaris | algae | 30'960.0 | 72 | 1 | 10 |
| Pereira et al.78 | 2014 | MWNT | EC44.67 | Chlorella vulgaris | algae | 50'000.0 | 96 | 1 | 10 |
| Pereira et al. 78 | 2014 | MWNT | EC54.4 | Chlorella vulgaris | algae | 100'000.0 | 96 | 1 | 10 |
| Simon-Deckers et al.79 | 2009 | MWNT | NOEC | Cupriavididus metallidurans | bacteria | 100'000.0 | 24 | 10 | 1 |
| Asharani et al.80 | 2008 | MWNT | NOEC | Danio rerio | zebrafish | 40'000.0 | 72 | 10 | 1 |
| Cheng et al.81 | 2007 | SWNT | LOEC | Danio rerio | zebrafish | 120'000.0 | 72 | 10 | 2 |
| Cheng et al. 81 | 2007 | DWNT | LOEC | Danio rerio | zebrafish | 240'000.0 | 72 | 10 | 2 |
| Zhu et al.64 | 2008 | SWNT | EC50 | Daphnia magna | crustacea | 1'306.0 | 48 | 10 | 10 |
| Edgington et al.82 | 2010 | MWNT | LC50 | Daphnia magna | crustacea | 2'000.0 | 96 | 10 | 10 |
| Zhu et al. 64 | 2008 | MWNT | EC50 | Daphnia magna | crustacea | 8'723.0 | 48 | 10 | 10 |
| Petersen et al.83 | 2011 | MWNT | EC50 | Daphnia magna | crustacea | 9'600.0 | 48 | 10 | 10 |
| Baumerte et al.84 | 2013 | MWNT | LC50 | Daphnia magna | crustacea | 11'480.0 | 48 | 10 | 10 |
| Alloy et al.72 | 2011 | MWNT | LOEC | Daphnia magna | crustacea | 240.0 | 504 | 1 | 2 |
| Petersen et al. | 2011 | MWNT | EC50 | Daphnia magna | crustacea | 12'700.0 | 48 | 10 | 10 |
| Sanchis et al.85 | 2016 | MWNT | EC50 | Daphnia magna | crustacea | 14'000.0 | 0.5 | 10 | 10 |
| Petersen et al. | 2011 | MWNT | EC50 | Daphnia magna | crustacea | 17'000.0 | 24 | 10 | 10 |
| Petersen et al. | 2011 | MWNT | EC50 | Daphnia magna | crustacea | 25'100.0 | 24 | 10 | 10 |
| Stanley et al.86 | 2016 | MWNT | LC50 | Daphnia magna | crustacea | 29'300.0 | 48 | 10 | 10 |
| Stanley et al. 86 | 2016 | MWNT | LC50 | Daphnia magna | crustacea | 4'300.0 | 336 | 1 | 10 |
| Roberts et al.87 | 2007 | SWNT | NOEC | Daphnia magna | crustacea | 5'000.0 | 96 | 10 | 1 |
| Sohn et al.77 | 2015 | SWNT | NOEC | Daphnia magna | crustacea | 100'000.0 | 48 | 10 | 1 |
| Martinez et al.88 | 2014 | MWNT | NOEC | Daphnia similis | crustacea | 30'000.0 | 48 | 10 | 1 |
| Blaise et al. 89 | 2008 | SWNT | EC50 | Hydra attenuata | unicellular | 1'000.0 | 96 | 1 | 10 |
| Martinez et al. 88 | 2012 | MWNT | NOEC | Oreochromis niloticus | vertebrate | 3'000.0 | 96 | 10 | 1 |
| Sohn et al. 77 | 2015 | SWNT | NOEC | Oryzias latipes | vertebrate | 100'000.0 | 96 | 10 | 1 |
| Schwab et al. 76 | 2011 | MWNT | NOEC  | Pseudokirchneriella subcapitata | algae | 1'300.0 | 96 | 1 | 1 |
| Schwab et al.76 | 2011 | MWNT | NOEC  | Pseudokirchneriella subcapitata | algae | 3'000.0 | 96 | 1 | 1 |
| Sohn et al. 77 | 2015 | SWNT | EC50 | Raphidocelis subcapitata | algae  | 29'990.0 | 72 | 1 | 10 |
| Bayat et al.90 | 2014 | SWNT | LED | Saccharomyces cerevisiae | bacteria | 7'800.0 | 16 | 10 | 2 |
| Zhu et al. 91 | 2006 | MWNT | NOEC | Stylonychia Mytilus | unicellular | 500.0 | 120 | 1 | 1 |
| Ghafari et al.92 | 2008 | SWNT | NOEC | Tetrahymena thermophila | protozoa | 6'800.0 | 72 | 1 | 1 |
| Ghafari et al. 92 | 2008 | SWNT | LOEC | Tetrahymena thermophila | protozoa | 3'600.0 | 72 | 1 | 2 |
| Blaise et al.89 | 2008 | SWNT | LC50 | Thamnocephalus platyurus | crustcea | 100'000.0 | 24 | 10 | 10 |
| Saria et al.93 | 2014 | MWNT | NOEC | Xenopus laevis  | vertebrate | 10'000.0 | 24 | 10 | 10 |
| Bourdiol et al.94 | 2013 | MWNT | LOEC | Xenopus laevis | vertebrate | 10'000.0 | 288 | 10 | 2 |
| Mouchet et al.71 | 2008 | DWNT  | LOEC | Xenopus laevis | vertebrate | 10'000.0 | 288 | 10 | 2 |
| Mouchet et al.95 | 2010 | MWNT | LOEC | Xenopus laevis | vertebrate | 50'000.0 | 288 | 10 | 2 |
| Cano et al.96 | 2017 | MWNT | EC50 | Daphnia magna | crustcea | 29'300.0 | 48 | 10 | 10 |

Legend: ECx = effective concentration at which a response of 'x' percent is observed; ICx = Inhibitory concentration at which an inhibition of 'x' percent is observed regarding a specific biological function.; LCx: lethal concentration that is expected to cause death to x% of the population. LOEC = lowest observed effect concentration; NOEC= no observed effect concentration;

Table S7. Results for the calculation of the PECs for each nano-form considered in Europe, Northern Europe and South Eastern Europe.



Table S8: Assessment factors used to convert acute to chronic values (AFt).97

|  |  |  |  |
| --- | --- | --- | --- |
| **Type of organism** | **Exposure time (days)** | **AFt** | **Reference** |
| Bacteria/Yeast | < 1 | 10 | (Berger, 2012, Cassidy-Hanley, 2012, Ron et al., 2010, Fok and Allen, 1979)98-101 |
| ≥ 1 | 1 |
| Algae | < 3 | 10 | (OECD, 2006a)102 |
| ≥ 3 | 1 |
| Plants (*L. minor*) | < 2.5 | 10 | (OECD, 2006b)103 |
| ≥ 2.5 | 1 |
| Other plants | < 28 | 10 | (OECD, 2006c)104 |
| ≥ 28 | 1 |
| Crustacea | < 21 | 10 | (OECD, 2004, OECD, 2012)105, 106  |
| ≥ 21 | 1 |
| Mollusca | < 28 | 10 | (OECD, 2016a, OECD, 2016b)107, 108 |
| ≥ 28 | 1 |
| Fish | < 28 | 10 | (OECD, 2000, OECD, 2009)109, 110 |
| ≥ 28 | 1 |

Table S9: Assessment factors used to convert dose descriptors into NOECs 70, 97

|  |  |
| --- | --- |
| **Type of dose-descriptor** | **AFdd** |
| LC25-50; EC25-50; IC25-50 | 10 |
| LC10-20; EC10-20; IC10-20 | 2 |
| LOEC |
| LED |
| MIC |
| HONEC | 1 |

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