**Table S1:** Classification of HMEI and HMPI

|  |  |  |
| --- | --- | --- |
| HMEI | HMPI | Pollution  |
| <10 | <15 | Low |
| 10-20 | 15-30 | Medium |
| >20 | >30 | High |

**Table S2:** Human exposure parameter values

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Factors**  | **Description** | **Unit** | **Adults** | **Children** |
| IR | Ingestion rate of water through drinking (l/day) | l/day | 2,2 | 1,8 |
| EF | Exposure frequency | days/year (350days) | 350 | 350 |
| ED | Exposure duration | years | 70 | 6 |
| BW | Average body weight | Kg | 70 | 15 |
| AT | Average time for non-carcinogenic effects | days  | 25550 | 2190 |
| SA | Exposed skin area | cm2 | 18000 | 6600 |
| ET | Exposure time | h/day | 0,58 | 1 |

**Table S3:** RfD and Kc for the analysed heavy metals (a Wu et al. (2009), b Wang et al. (2017), c USEPA (2004), d USEPA (2019))

|  |  |  |  |
| --- | --- | --- | --- |
| **Trace metal** | **Kp c** | **RfD ingestion (μg/kg/day)** | **RfD dermal (μg/kg/day)** |
| As a | 1 × 10−3 | 0.3 | 0.285 |
| Cu b | 1 × 10−3 | 40 | 8 |
| Pb b | 1 × 10−4 | 1,4 | 0,42 |
| Ni b | 2 × 10−4 | 20 | 0,8 |
| Co b | 4 × 10−4 | 0,3 | 0,06 |
| Cr b | 1 × 10−3 | 3 | 0,075 |
| Cd b | 1 × 10−3 | 0,5 | 0,025 |
| Mn b | 1 × 10−3 | 24 | 0,96 |
| Fe b | 1 × 10−3 | 700 | 140 |
| Al b | 1 × 10−3 | 1000 | 200 |
| Zn b | 6 × 10−4 | 300 | 60 |
| F d |   | 40 |  |

**Table S4:** Classification of chronic (non-carcinogenic) risk (USEPA, 1999)

|  |  |  |
| --- | --- | --- |
| **Risk level** | **HI** | **Chronic risk** |
| 1 | <0,1 | Negligible |
| 2 | >0,1<1 | Low |
| 3 | >1<4 | Medium |
| 4 | > 4 | High |

**Table S5:** Slope factor values

|  |
| --- |
| Slope Factor (mg/(kg day)) |
| As | 1,5 |
| Pb | 0,0085 |
| Cr | 0,05 |
| Cd | 0,05 |
| Ni | 0,91 |

**Table S6:** Physico-chemical parameters, major ions, heavy metal and E. coli data of surface water in the study area

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **N** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** |  |  |  |
| **Name 1** | **Bloemhof Dam.** | **Vaalharts Dam.** | **Spitskop Dam.** | **Canal 1** | **Pudimoe Raw** | **Bogosing Raw** | **kgomosto Raw** | **Pampierstard Raw** | **Schweizer** | **Taung Dam** |  **River 1** | **Min** | **Max** | **Avg** |
| **Name 2** | **Vaal - BHD** | **Vaal - VH** | **Harts - SPD** | **Canal 1** | **NPO2** | **NB1** | **NK1** | **NP1** | **NSC1** | **TD** | **TR** |  |  |  |
| **pH** | **7.8** | **7,9** | **8,3** | **8** | **8,3** | **8,9** | **8,6** | **8,1** | **8,8** | **8,7** | **8,7** | **7,9** | **8,9** | **8,43** |
| **EC mS/m** | **47,3** | **47,4** | **104** | **62** | **45** | **43** | **112** | **49** | **36** | **38** | **39** | **36** | **112** | **56,60** |
| **TDS mg/l** | **307** | **308** | **677** | **395** | **284** | **270** | **774** | **476** | **-** | **247** | **253** | **247** | **774** | **399,1** |
| **Na mg/l** | **33** | **32** | **91** | **55** | **25** | **24** | **106** | **63** | **-** | **29,48**  | **30,81**  | **24** | **106** | **48,92** |
| **K mg/l** | **7,4** | **8** | **9,2** | **10** | **8,5** | **8,9** | **11** | **12** | **-** | **7,23**  | **8,99**  | **7,228** | **12** | **9,12** |
| **Ca mg/l** | **32,7** | **34,3** | **43,2** | **44,4** | **39** | **40** | **80** | **54** | **-** | **23,14**  | **25,65**  | **23,14** | **80** | **41,63** |
| **Mg mg/l** | **14** | **14,5** | **48,6** | **20,2** | **14** | **13** | **52** | **33** | **-** | **10,94**  | **12,53**  | **10,93** | **52** | **23,27** |
| **Alk mg/l** | **112** | **113** | **180** | **165** | **115** | **116** | **185** | **120** | **-** | **152,54**  | **158,64**  | **112** | **185** | **141,71** |
| **SO4 mg/l** | **65** | **64** | **185** | **137** | **64** | **50** | **223** | **79** | **50** | **14,44**  | **14,18**  | **14,18**  | **223**  | **85,97**  |
| **NO3- N mg/l** | **0,18** | **0,18** | **0,18** | **0,36** | **0,5** | **0,5** | **3,6** | **1,6** | **0,5** | **1,28**  | **0,91**  | **0,18**  | **3,60**  | **0,89**  |
| **Cl mg/l** | **35** | **35** | **118** | **54,4** | **29** | **27** | **146** | **38** | **10** | **33,68**  | **33,68**  | **10**  | **146** | **50,89**  |
| **Al μg/l** | **383** | **558** | **573** | **-** | **1400** | **1300** | **1400** | **200** | **-** | **1026** | **904**  | **200** | **1400**  | **860,44**  |
| **Fe μg/l** | **100** | **100** | **100** | **90** | **520** | **880** | **1100** | **210** | **-** | **50,00**  | **40**  | **40**  | **1100**  | **319,00**  |
| **Mn μg/l** | **50** | **50** | **50** | **10** | **100** | **100** | **100** | **100** | **-** | **-** | **-** | **10** | **100** | **70** |
| **Cr μg/l** | **4** | **4** | **4** | **-** | **4,5** | **2** | **3** | **2** | **-** | **1,50**  | **0,60**  | **0,60**  | **4,50**  | **2,84**  |
| **Cu μg/l** | **50** | **50** | **50** | **20** | **100** | **100** | **100** | **100** | **-** | **20,00**  | **10**  | **10**  | **100**  | **60,00**  |
| **Zn ug/l** | **200** | **200** | **200** | **30** | **100** | **100** | **100** | **100** | **-** | **-** | **-** | **30** | **200** | **128,75** |
| **F ug/l** | **300** | **300** | **500** | **400** | **500** | **500** | **500** | **-** | **-** | **-** | **-** | **300** | **500** | **428,57** |
| **B μg/l** | **100** | **100** | **150** | **80** | **-** | **-** | **152** | **-** | **-** | **-** | **-** | **80** | **152** | **110,33** |
| **As μg/l** | **7** | **7** | **7** | **-** | **10** | **10** | **-** | **10** | **-** | **4,30**  | **3,20**  | **3,20**  | **10,00**  | **7,31**  |
| **Cd μg/l** | **1** | **1** | **1** | **-** | **3** | **3** | **3** | **3** | **-** | **5,00**  | **4,00**  | **1,00**  | **5,00**  | **2,67**  |
| **Hg μg/l** | **-** | **-** | **-** | **-** | **4** | **4** | **4** | **4** | **-** | **7,50**  | **2,80**  | **2,80**  | **7,50**  | **4,38**  |
| **Pb μg/l** | **6** | **6** | **6** | **-** | **4** | **4** | **4** | **4** | **-** | **4,10**  | **3,90**  | **3,90**  | **6,00**  | **4,67**  |
| **PO4 ug/l** | **800** | **800** | **800** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **800** | **800** | **800** |
| **Ni ug/l** | **-** | **-** | **-** | **-** | **4** | **4** | **4** | **4,3** | **-** | **0,50**  | **0,30**  | **0,30**  | **4,30**  | **2,85**  |
| **Sb ug/l** | **-** | **-** | **-** | **-** | **10** | **10** | **10** | **10** | **-** | **0,40**  | **0,40**  | **0,40**  | **10,00**  | **6,80**  |
| **Se ug/l** | **-** | **-** | **-** | **-** | **10** | **10** | **10** | **10** | **-** | **0,41**  | **0,25**  | **0,25**  | **10,00**  | **6,78**  |
| **E. coli cfu/100ml** | **28** | **39** | **15** | **12** | **15** | **21** | **727** | **1120** | **167** | **80,00**  | **36,00**  | **12,00**  | **1120,00**  | **205,45**  |

**Table S7:** Cancer risk of trace metals by ingestion and dermal absorption pathway

|  |  |
| --- | --- |
| **Samples** | **Adult** |
| **Oral ingestion** | **Dermal** |
| **CR As** | **CR Pb** | **CR Cr** | **CR Cd** | **CR Ni** | **CR As** | **CR Pb** | **CR Cr** | **CR Cd** | **CR Ni** |
| 1 | 0,316438 | 0,001537 | 0,006027 | 0,001507 | - | 0,150164 | 7,29E-05 | 0,00286 | 0,000715 | - |
| 2 | 0,316438 | 0,001537 | 0,006027 | 0,001507 | - | 0,150164 | 7,29E-05 | 0,00286 | 0,000715 | - |
| 3 | 0,316438 | 0,001537 | 0,006027 | 0,001507 | - | 0,150164 | 7,29E-05 | 0,00286 | 0,000715 | - |
| 4 | - | - | - | - | - | - | - | - | - | - |
| 5 | 0,452055 | 0,001025 | 0,006781 | 0,004521 | 0,109699 | 0,214521 | 4,86E-05 | 0,003218 | 0,002145 | 0,010411 |
| 6 | 0,452055 | 0,001025 | 0,003014 | 0,004521 | 0,109699 | 0,214521 | 4,86E-05 | 0,00143 | 0,002145 | 0,010411 |
| 7 | 0 | 0,001025 | 0,004521 | 0,004521 | 0,109699 | 0 | 4,86E-05 | 0,002145 | 0,002145 | 0,010411 |
| 8 | 0,452055 | 0,001025 | 0,003014 | 0,004521 | 0,117926 | 0,214521 | 4,86E-05 | 0,00143 | 0,002145 | 0,011192 |
| 9 | - | - | - | - | - | - | - | - | - | - |
| 10 | 0,194384 | 0,00105 | 0,00226 | 0,007534 | 0,013712 | 0,092244 | 4,98E-05 | 0,001073 | 0,003575 | 0,001301 |
| 11 | 0,144658 | 0,000999 | 0,000904 | 0,006027 | 0,008227 | 0,068647 | 4,74E-05 | 0,000429 | 0,00286 | 0,000781 |
| Samples | Children  |
| Oral ingestion | Dermal |
| CR As | CR Pb | CR Cr | CR Cd | CR Ni | CR As | CR Pb | CR Cr | CR Cd | CR Ni |
| 1 | 1,208219 | 0,005868 | 0,023014 | 0,005753 | - | 4,430137 | 0,002152 | 0,084384 | 0,021096 | - |
| 2 | 1,208219 | 0,005868 | 0,023014 | 0,005753 | - | 4,430137 | 0,002152 | 0,084384 | 0,021096 | - |
| 3 | 1,208219 | 0,005868 | 0,023014 | 0,005753 | - | 4,430137 | 0,002152 | 0,084384 | 0,021096 | - |
| 4 | - | - | - | - | - | - | - | - | - | - |
| 5 | 1,726027 | 0,003912 | 0,02589 | 0,01726 | 0,418849 | 6,328767 | 0,001435 | 0,094932 | 0,063288 | 0,307156 |
| 6 | 1,726027 | 0,003912 | 0,011507 | 0,01726 | 0,418849 | 6,328767 | 0,001435 | 0,042192 | 0,063288 | 0,307156 |
| 7 | - | 0,003912 | 0,01726 | 0,01726 | 0,418849 | 0 | 0,001435 | 0,063288 | 0,063288 | 0,307156 |
| 8 | 1,726027 | 0,003912 | 0,011507 | 0,01726 | 0,450263 | 6,328767 | 0,001435 | 0,042192 | 0,063288 | 0,330193 |
| 9 | - | - | - | - | - | - | - | - | - | - |
| 10 | 0,742192 | 0,00401 | 0,00863 | 0,028767 | 0,052356 | 2,72137 | 0,00147 | 0,031644 | 0,105479 | 0,038395 |
| 11 | 0,552329 | 0,003815 | 0,003452 | 0,023014 | 0,031414 | 2,025205 | 0,001399 | 0,012658 | 0,084384 | 0,023037 |