



Potensieel-problematiese elemente in die sediment en vis van die Oranje-Vaalrivierstelsel

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Potentially problematic elements in sediment and fish from the Orange-Vaal River system.

Levels of Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Ag, Cd, Pt, Au, Hg, Tl, Pb and U were investigated in sediment and fillet tissue (*Clarias gariepinus*), from sites along the Orange-Vaal River system, South Africa. Sediment sampling sites were chosen up- and downstream of major pollution sources such as mining, industrial and farming areas. The two fish collection sites in the Vaal River were Standerton and Parys and in the Orange River, Boegoeberg and Rooipoort. ICP-MS analysis was done to determine the concentrations the elements. Indices were calculated to describe the quality of the sediment regarding a number of factors: The enrichment factor (Ef) of individual elements evaluated elevation in levels above natural geology whereas the geo-accumulation index (Igeo) determined the degree of pollution by the enrichment levels of the individual elements at each site. The pollution effect of the total mixture of elements at each site was investigated by the elemental contamination index (ECI) and pollution load index (PLI). The ECI is the geometric mean concentrations of elements, while the PLI uses the contamination factor (Cf), that is, how many times the measured concentration is higher than a background value. Ecological risk was determined by calculating the sediment quality guideline index (SQG-I) at each site. The SQG-I is the arithmetic mean of how many times the measured concentration of individual elements at a specific site were higher than a guideline level. In this case, threshold sediment quality guideline values for Australia, the Netherlands, and Canada were used, since South Africa does not have them. In addition, a sediment quality index (SQI) was calculated to incorporate the percentage of elements that did not meet guidelines and the magnitude of exceedance. The bio-accumulation factor (BF) was also calculated between the sediment and the fish.

The Igeo and Ef of Se, Ag and Au were the highest at all the sites. The Parys site had the most elements that were enriched to different degrees, but the Rooipoort site had the highest ECI and PLI. The SQG-I indicated that three of the four sites had a moderate chance of posing an ecological risk to its biota. However, the Rooipoort site had a high probability to be toxic to biota. The SQI classified Rooipoort as 'fair' in terms of sediment quality and the rest of the sites as 'good'. The elemental concentrations present within the fish were below the allowed standards for human consumption. Se, Ag, Pt, Au and Hg were the elements that bio-accumulated most in the fish.

Die vlakke van Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Ag, Cd, Pt, Au, Hg, Tl, Pb en U is vir sediment en vis (*Clarias gariepinus*) in die Oranje-Vaalrivierstelsel ondersoek. Die ses versamelingspunte vir sediment was stroom-op en stroom-af van besoedelingsbronne soos landbou, mynbou en industrieë. Daar was drie visversamelingspunte in die Vaalrivier (Rooipoort, Standerton en Parys) en een in die Oranjerivier (Boegoeberg). Die konsentrasie van die elemente is deur IKP-MS analise bepaal. Indekse is bereken om die kwaliteit van die sediment in terme van verskeie faktore, te beskryf: die verrykingsfaktor (Vf) vir individuele elemente is bereken om vas te stel tot watter mate die vlakke hoër is as wat die natuurlike geologie sou kon verklaar. Die geo-akkumuleringindeks (Igeo) bepaal die graad van besoedeling wat veroorsaak is deur die verrykingsvlakke van die individuele elemente by elke monsternemingspunt. Die besoedelingseffek wat veroorsaak word deur die totale elementmengsel is bepaal deur die elementkontaminasie-indeks (EKI) en die besoedelingladingsindeks (BLI) te bereken. Die EKI is die geometriese gemiddeld van die elementkonsentrasies en die BLI gebruik die kontaminasiefaktor (Kf). Die Kf dui aan hoeveel keer 'n gemete konsentrasie hoër is as die verwagte agtergrondvlak. Ekologiese risiko is bepaal deur die sedimentkwaliteitsriglynindeks (SKR-I) van elke monsternemingspunt. Die SKR-I is die wiskundige gemiddeld van die aantal keer wat die gemete konsentrasie van die individuele elemente hoër is as die riglynwaarde. Vir voorgeskrewe drumpelwaarde-sedimentkwaliteit, is dié van Australië, Nederland en Kanada gebruik omdat Suid-Afrika nie daarvoor beskik nie. Die sedimentkwaliteitsindeks (SKI) is ook bereken om die persentasie elemente wat nie aan die drumpelwaarde-sedimentkwaliteit voldoen nie, te bepaal. Die bio-akkumulering vir elemente



vanaf die sediment na die vis is ook bereken en word uitgedruk as die bio-akkumuleringsfaktor (Bf).

Die Igeo en Kf van Se, Ag en Au was die hoogste by al die versamelingspunte. Die elemente by Parys was die meeste verryk maar Rooipoort het die hoogste EBI en BLI gehad. Die SKR-I het getoon dat drie van die vier studiegebiede se elemente 'n matige risiko het om toksies vir die biota

te wees. Rooipoort het dus 'n groter waarskynlikheid om toksies vir biota te wees. Die SKI het Rooipoort geklassifiseer as 'matig' in terme van sedimentkwaliteit en die res van die areas het as 'goed' gekwalifiseer. Die elementkonsentrasie in die vis was laer as die aanvaarde internasionale voedselriglyne van wêreldgesondheidsorganisasie (WGO) en die Voedselgesondheidsorganisasie (VGO). Ag en Au het die meeste in die visweefsel geakkumuleer.