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RESEARCH ARTICLE

Cadmium and arsenic levels in edible fishes, *Oreochromis niloticus* (Nile tilapia) and *Ompok bimaculatus* (butter catfish) from Padaviya Reservoir, Sri Lanka and human health risk assessment associated with their dietary exposure

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Abstract: Consumption of fish contaminated with toxic heavy metals is a threat to human health. Cadmium and arsenic are suspected as potential risk factors for chronic kidney disease of unknown aetiology (CKDu), which is highly prevalent in agricultural settlements in dry zone districts of Sri Lanka causing a severe public health crisis. Objectives of this study were (i) to determine cadmium and arsenic levels in muscle, liver and kidney of two edible fishes (Nile tilapia and butter catfish) from the Padaviya reservoir located in the North Central Province, Sri Lanka where CKDu is highly prevalent and (ii) to assess the potential human health risks associated with the dietary exposure through edible muscle of these fishes. Cadmium and arsenic levels of the tissues in the two fish species were determined using inductively coupled plasma mass spectrometry. In both fish species, highest cadmium levels were found in kidney ($p < 0.05$) whereas no significant tissue specific differences ($p > 0.05$) were evident for arsenic. In the edible muscle, the maximum detected cadmium level in Nile tilapia was 0.1 mg/kg in wet weight. However, cadmium levels in the muscle of all Butter catfish were < 0.05 mg/kg. Arsenic levels in the muscle of all Nile tilapia and Butter catfish were < 0.05 mg/kg. Cadmium contents in muscle of most fishes and arsenic contents in all fishes ($n = 60$) were within the maximum permissible limits set by the international food standards regulatory authorities. Based on the estimated daily intake and target hazard quotients (< 1) for lifetime exposure, it is highly unlikely that cadmium and arsenic contents of the muscle meat of these fishes would pose human health risks to moderate level consumers.

Keywords: Chronic kidney disease, heavy metal, ICP-MS, North Central Province, Padaviya reservoir fish, risk assessment.

INTRODUCTION

Consumption of fish provides an important source of protein, polyunsaturated fatty acids and essential minerals which are associated with health benefits and normal growth. However, contamination of fish with toxic heavy metals can affect the nutritional and other beneficial effects of fish on human health (Castro-González & Méndez-Armenta, 2008). Due to the high degree of toxic effects, some heavy metals and metalloids such as cadmium and arsenic have been ranked as priority metals that are of public health significance. Cadmium and arsenic are systemic toxicants that could induce multiple organ damage, even at lower levels of exposure (Tchounwou *et al.*, 2012; Karri *et al.*, 2016; Wise *et al.*, 2017). Inorganic forms of arsenic in food appears to be more toxic than the organic arsenic forms (USEPA, 2000; Castro-González & Méndez-Armenta, 2008; Varol & Sünbül, 2018).

Chronic kidney disease of unknown aetiology (CKDu) is an emerging health problem in some low-

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RESEARCH ARTICLE

Optimising usage of salinized lands in the lower part of the river basin for the coastal community in Bentota, Sri Lanka

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Abstract: Land degradation in coastal areas due to seawater intrusion, and coastal salinity is one of the major critical problems affecting the sustainable development of Sri Lanka. Coastal salinity risk is increasing in the Bentota area while diminishing land productivity which results in poor food production and giving rise to several socio-economic issues for the community in the area. Bentota is below the agricultural production capacity level and no strategy has been implemented or introduced so far regarding the utilisation of degraded lands in the area. This study identified the optimised extent of salinized lands for paddy, coconut, vegetables, fruits, tea, rubber and cinnamon cultivations based on future coastal salinity effects, land use demand and the development trend of the area. Land use change, rainfall, temperature, topography, floods, soil, ground and surface water are the factors applied in evaluations of land use suitability as the prior requirement for land use optimisation. Future demands of land use were predicted applying population growth models, the theory of land carrying capacity and the ecological footprint. Strategies for optimising the productivity of salinized lands were identified using a stakeholder perception-based approach. The developed sustainable land use pattern will enhance the land productivity of highly (3.4 %), moderately (39.6 %) and slightly (57 %) salinized areas in Bentota. Identified land management strategies will facilitate the spatial planning of future land use of this area by providing guidance to the local authority in the process of allocating salinized lands for enhancing land productivity.

Keywords: Future demand analysis, land use pattern, linear programming model, population forecasting, optimising salinized lands, seawater intrusion

INTRODUCTION

Coastal ecosystems are among the most economically productive areas and densely populated regions in the world (Barbier, 2012). Coastal surface water bodies hydraulically linked to the ocean are subject to seawater intrusion at varying levels. Saltwater intrusion (SWI) into freshwater coastal rivers and aquifers has been and continues to be one of the most significant global challenges for coastal water resource managers, coastal city planners, industries and agriculture (Ferguson & Gleeson, 2012). There are many factors that can influence the dynamic equilibrium between freshwater and sea water and contribute to SWI in a coastal aquifer (Costa, 2008). These influences include both natural variations and anthropogenic activities. The natural factors include climate change and sea-level rise, groundwater extraction and recharge, aquifer hydraulic properties, tidal exchange, rainfall, prolonged drought and the effect of gravitational forces (Costa, 2008; Williams, 2010; Werner *et al.*, 2013). Many activities of economic development such as agriculture, fisheries, industries, human settlement and transportation make significant impacts on the mechanics of SWI (Costa, 2008). Han *et al.* (2010) showed the vulnerability of Sri Lanka as an island to the effects of sea level rise in near future, which will be on average +12 cm per century. Taking precautionary steps for the now foreseen threats is highly important because Indian Ocean sea-level rise affects the

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