

ABSTRACT

The efficient use of finite water resources and measures to extend the service value of these resources in water scarce countries is a pre-requisite for achieving sustainable development. There is constant pressure to explore new resources to meet the ever increasing demand posed by growth in population and that of industry in urban cities.

Introduction of unconventional resources such as wastewater and greywater reuse, allows access to a readily available valuable resource and intrinsic value recovery for the benefit of society. Not only does this assist with fresh water resource conservation and optimal use thereof and mitigation of negative impacts but also closing of urban nutrient loops and extraction of chemical energy for energy generation.

This research explores wastewater intrinsic value recovery at wastewater treatment plant and wastewater management system levels as part of the balancing equation of natural-unconventional resource use and environmental, social and economic constraints. A methodology for assessment of wastewater intrinsic value recovery was developed that derive a monetary equivalent of value recovery of reuse employing an econometric production function approach. Apart from a economic level life cycle analysis, the methodology developed include a holistic multi-criteria analysis (MCA) covering sustainability criteria related to the economic, technical, social and environmental domains. The methodology can be adopted to analyse the economic effects of choices between the different pathways of wastewater intrinsic value recovery or a combination thereof and performance differences between surface and ground water reclamation strategies. The methodology allows strategic level comparative analyses of wastewater management system options within the centralised-decentralised wastewater continuum and appropriate technology option choices, being demonstrated for sewer technology in the second case study of the research.

It is concluded that wastewater beneficiation or intrinsic value recovery consists of three different pathways of reclamation, reuse and recycle, each being location

specific with different social, environmental and economic repercussions. While reuse positively impact virtual water components and water footprints, modification to allow multiple water use is needed to apply the concept in wastewater management. By quantifying the impact of reuse on water availability for urban water supply systems the link between reuse level and resource conservation benefits is established.

The main recommendations made include the exploring of shadow prices and contaminant removed at treatment and management system levels over multiple time periods. In addition, sustainability of extended system scale and technology options over the centralised-decentralised wastewater continuum and returns to scale of urban sewerage systems within a South African context require investigation. The adoption of the methodology is also proposed to analyse the economic impacts of wastewater beneficiation pathways or combinations thereof, additional benefits of multiple water use and ways of adjustment of the virtual water (VW) concept to be more amenable to wastewater management. Furthermore, impact of reuse on increased water availability for urban water supply systems by incorporating a network-specific and consumer-end related system losses differentiation as link to resource conservation benefits assessment is also recommended.