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Environmental fate and risk analysis of agrochemical use around lake Naivasha.

C.Mannaerts[1], W.Siderius[2] and Tang Zhen Xu[1] (ITC)

Extended abstract

The use of agro-chemicals is common practice in the lake Naivasha riparian zone agricultural area. In view of the environmental concerns about the potential impacts of chemical substances and the fate of their residues in ecosystems, a screening-level study was undertaken aiming to evaluate the risks associated to use of fertilizers and pesticides in the Naivasha area.

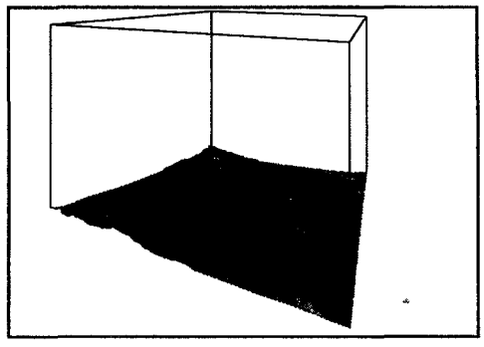

Figure 1: 3-D view of Naivasha ecosystem compartments used in the environmental partitioning analysis

Ecosystem partitioning analysis:

As a first reconnaissance survey, and in order to scope the potential environmental problems related to chemical use in the area, a ecosystem partitioning exercise was performed, for a number of commonly used substances in the near-lake zone. The simplified ecosystem concept of McCall et al (1983), as described by Hounslow (1995) was adopted. A pond model system is being used, as shown in a 3-D view in Figure 1. The area concerned represents a 20x20 km^2 lake area. Field surveys on agrochemical use (Morgan, 1998; Tang, 1999) led to more than 60 pesticides being used on a common basis. Among them, chemicals of concern retained were those classified as hazardous to extremely hazardous (WHO and/or US.EPA classes II, I and Ia) respectively, Fenamiphos, Methomyl, Chlorpyrifos, Oxamyl and Dimethoate. The partitioning analysis permits to screen potential residue levels to be found in the various compartments i.e., soil, water soluble, sediment and vertebrate (e.g., lake fish through bio accumulation), as a function of pesticide loads used in the area.

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[1] Water Resources and Environmental Studies Division, International Institute of Aerospace Surveys & Earth Sciences (ITC), Enschede, the Netherlands

[2] Soil Sciences Division, International Institute of Aerospace Surveys & Earth Sciences (ITC), Enschede, the Netherlands

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Contaminant Transport and Pathway analysis:

In order to analyze the hydrology and chemistry of the fate processes of the substances used in the area, a model-based analysis is being performed to verify the feasibility and importance of the five major fate processes or dissipation transport pathways of substances i.e., soil accumulation, leaching to vadose zone and groundwater, chemical surface runoff, volatization and bio-degradation. Four screening-type models are being used and compared i.e., Sesoil v.3.0, Pestan v.4.0, Przm2 and Wave v.2.1.

The chemical, physical and biological properties of a substance, in conjunction with the climate, hydrologic and soil environment characteristics of an area, are the main drivers of the processes associated with transport and transformation of a chemical. Soil survey and characterization of vadose zone was done, in order to evaluate soil-water budgets for various agricultural cultivation scenarios such as crop types (french beans, roses, etc.), irrigation modes, greenhouse or rainfed conditions. Preliminary results indicate, that although the majority of combinations of pesticide application, crop type and cultivation technique does not present an immediate pollution or health risk, certain scenarios i.e, local site conditions (groundwater depth, proximity to lake, soil type and properties) in combination with a certain crop and pesticide application, can potentially present contamination risk (i.e., groundwater breakthrough, chemical runoff to lake). The model assumptions and simulations are currently being verified and put in perspective with field surveys and chemical analysis data of lake, groundwater and soil samples. Results are being merged within a geographic information system framework to permit a spatial analysis and provide a generic overview of the contamination vulnerability and risk in the Naivasha area.

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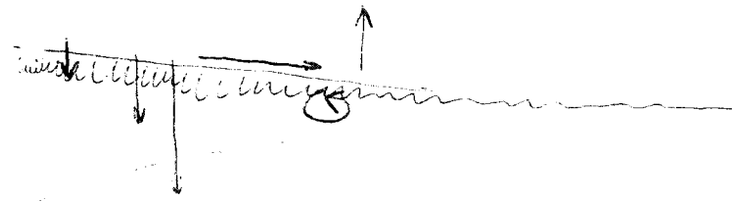

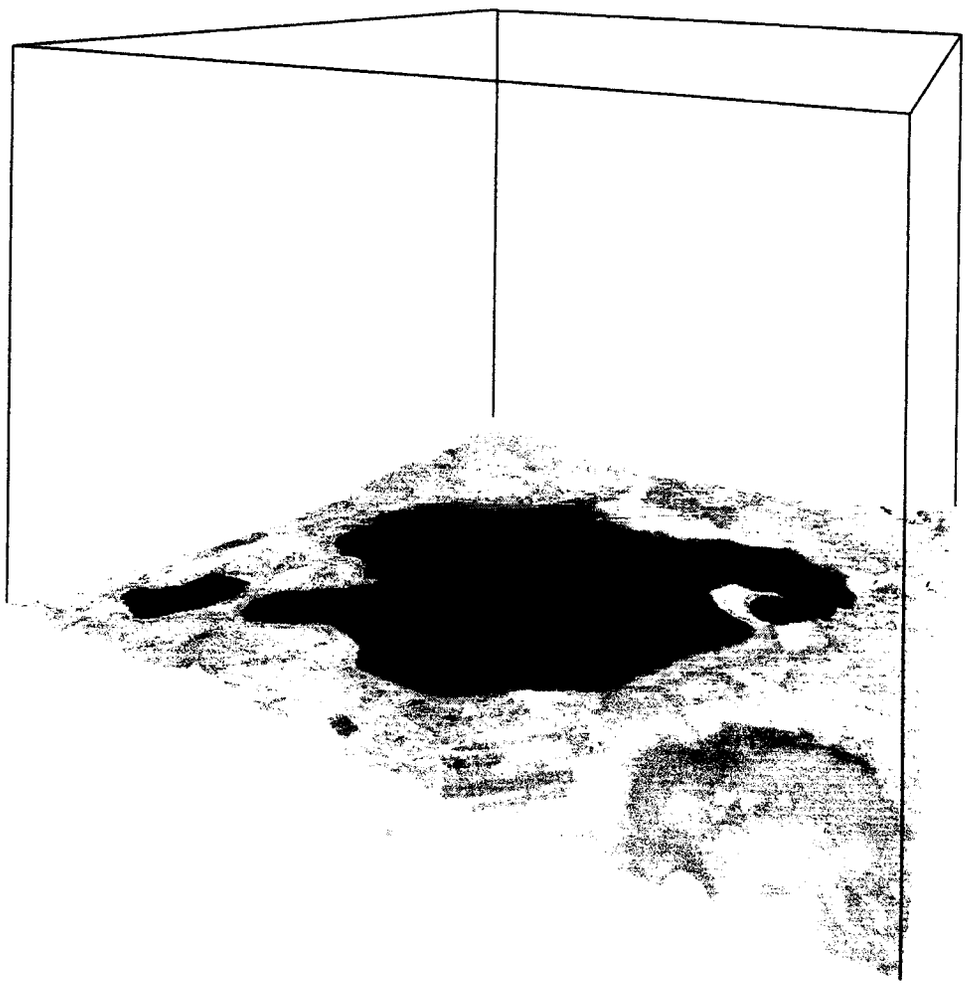

Fig.1: 3-dimensional view of Naivasha ecosystem compartments used in environmental partitioning analysis