Institute for Mathematics and its Applications
2012 Seminar Series
University of Wollongong

Title: Mathematical modelling of self-heating in compost piles

Speaker: Thiansiri Luangwilai (University of New South Wales)

Time and Date: 3:30pm, Wednesday 9 May 2012

Location: Room 24.103

Abstract: Due to environmental concerns about waste management and global warming, composting has become an increasingly popular method for handling organic waste, manure and other organic materials as it is an inexpensive, simple and environmentally friendly process. However, due to the lack of a fundamental understanding of the self-heating processes inside a compost heap, there have been many fire accidents in composting facilities such as those storing industrial waste products like municipal solid waste and landfills. In most cases, these incidents have been manageable and not destructive enough to attract outside attention. However, over the years, there have been several notably devastating fires at such facilities which have created financial losses in addition to damage to lives, facilities, the environment, etc.

The models incorporate terms that account for both the biological and chemical heating processes which occur within compost piles. To date, only the latter mechanism has been analysed using models for internal heating in bulk solids such as coal, grain, hay, etc. However, the main decomposition and stabilisation processes of organic materials within a compost pile are due to the biological reaction which is both a heat-generating and dehydrating process. The biological decomposition process works effectively within the elevated temperature range of 323 – 363 K but, above this temperature, the chemical or oxidative reaction "kicks in" which sometimes generates too much heat and triggers spontaneous ignition within compost piles.

In this presentation, detailed investigations of several mathematical models for the self-heating of a compost heap are presented. Firstly, the generic solution behaviour of the self-heating process within a compost pile and then the mechanisms which maximise the composting process whilst minimising the chance of spontaneous ignition within a compost heap are examined. To improve composting performance, we determine compost pile behaviour as a function of several important factors, such as the compost pile size, air-flow rate, ambient temperature and water content. These studies give us a better understanding of the composting process so that, in industrial composting facilities, we are able to monitor and adjust these factors to achieve optimum outcomes.