Istituto Veneto di Scienze Lettere ed Arti

SUMMER SCHOOL ON BIOGEODYNAMICS AND EARTH SYSTEM SCIENCES

BESS

# TRANSIENT DECAY OF LITTERFALL IN A TROPICAL FRESH WATER ECOSYSTEM


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# OUTLINE:

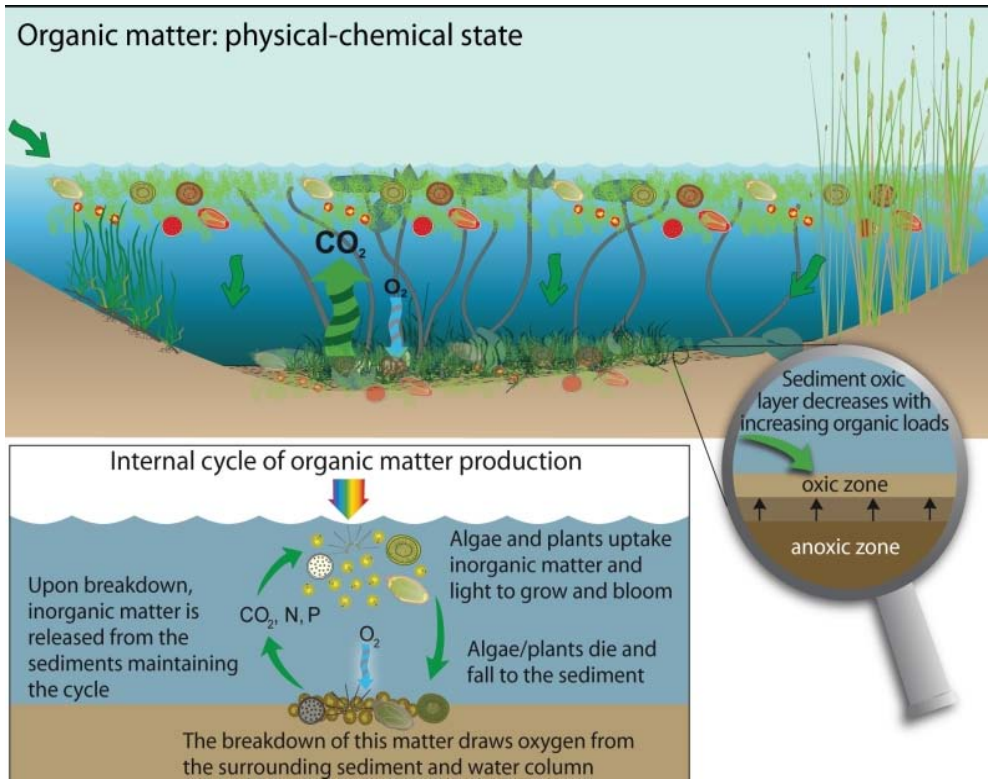
1 - Brief introduction

2 - Case study

3 - Mathematical Model:

- Disordered Kinetics Approach
- Impulse Response

4 - Conclusion




Organic matter (OM), in dissolved or particulate forms, is found in every water body - oceans and fresh water of all types

Most analytical methods for measuring organic matter in water actually determine the carbon content.

The OM that is of natural origin is derived primarily from plant and / or microbial residues

**AQUEOUS Organic Matter**

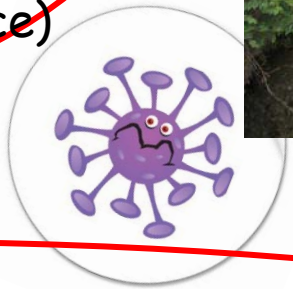
# OUR EXERCISE:

The decomposition process of the Aqueous Organic Matter production is:

- 1 - NOT homogeneous: *i.e.* input composition heterogeneity, decomposer species, irregular flow…

- 2 - NOT constant: vary in time (and space)

THE PROBLEM



OUR THINKING!!!

SO:

-1- We applied the Disordered Kinetics Approach described in Prof.Rothman lesson because it is useful to capture such a complexity

-2- Seasonal Input: we use sinusoidal function of time

# THE PROBLEM

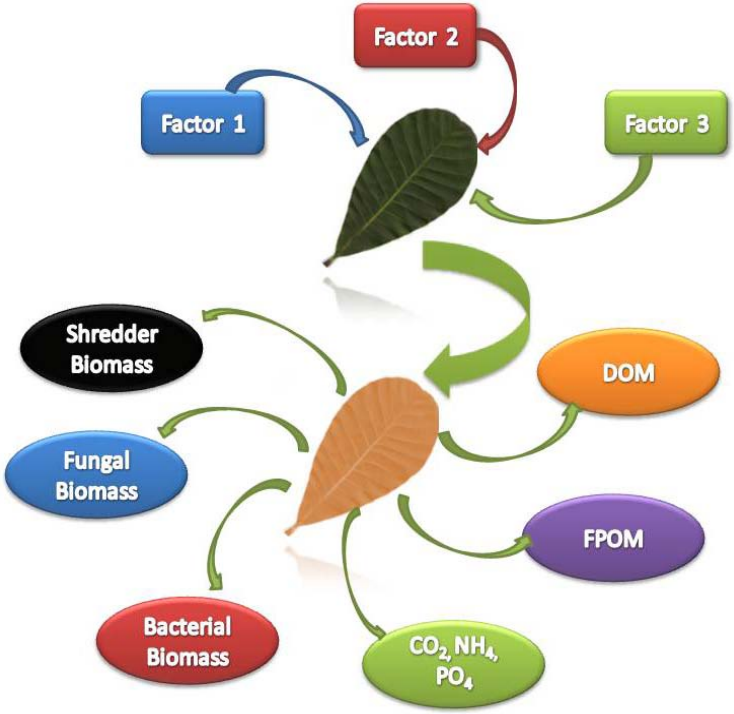
**Trying to capture heterogeneity representation…**

*…Probability distribution function of the decay rate (magnitude and variability)*

**Do we need lots of information of a single species to obtain the probability distribution of its breakdown rate?**

*Sure or…*

*You can solve the inverse problem from a "**Disordered Kinetics Approach**"*



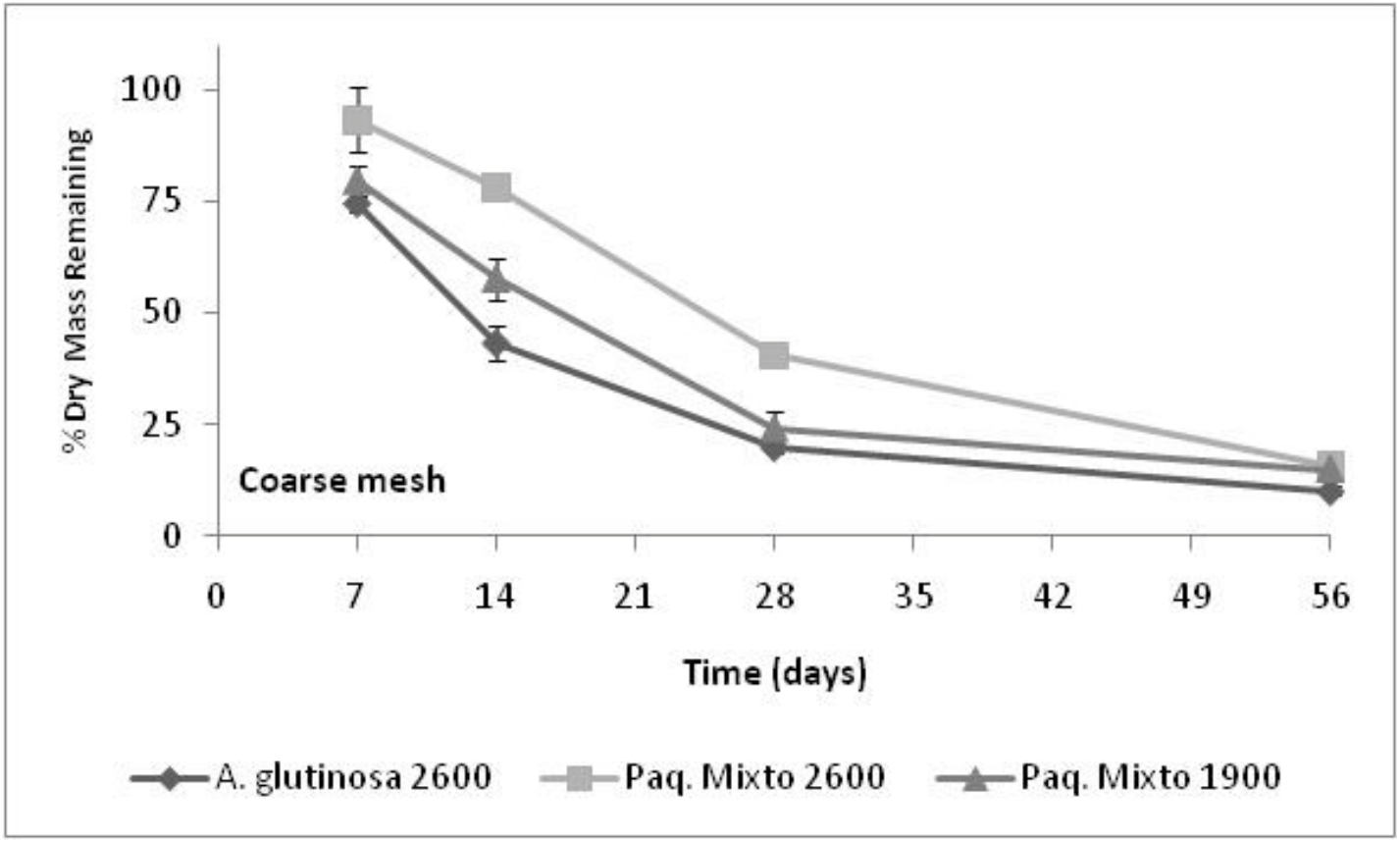
THE POSSIBLE SOLUTION:

## Disordered kinetics

- Assume that a continuum of rates $k$ contribute to decay (e.g., Boudreau and Ruddick, 1991).
- Assume that these rates are effectively random, drawn from an *unknown* probability distribution $p(k)$. Then

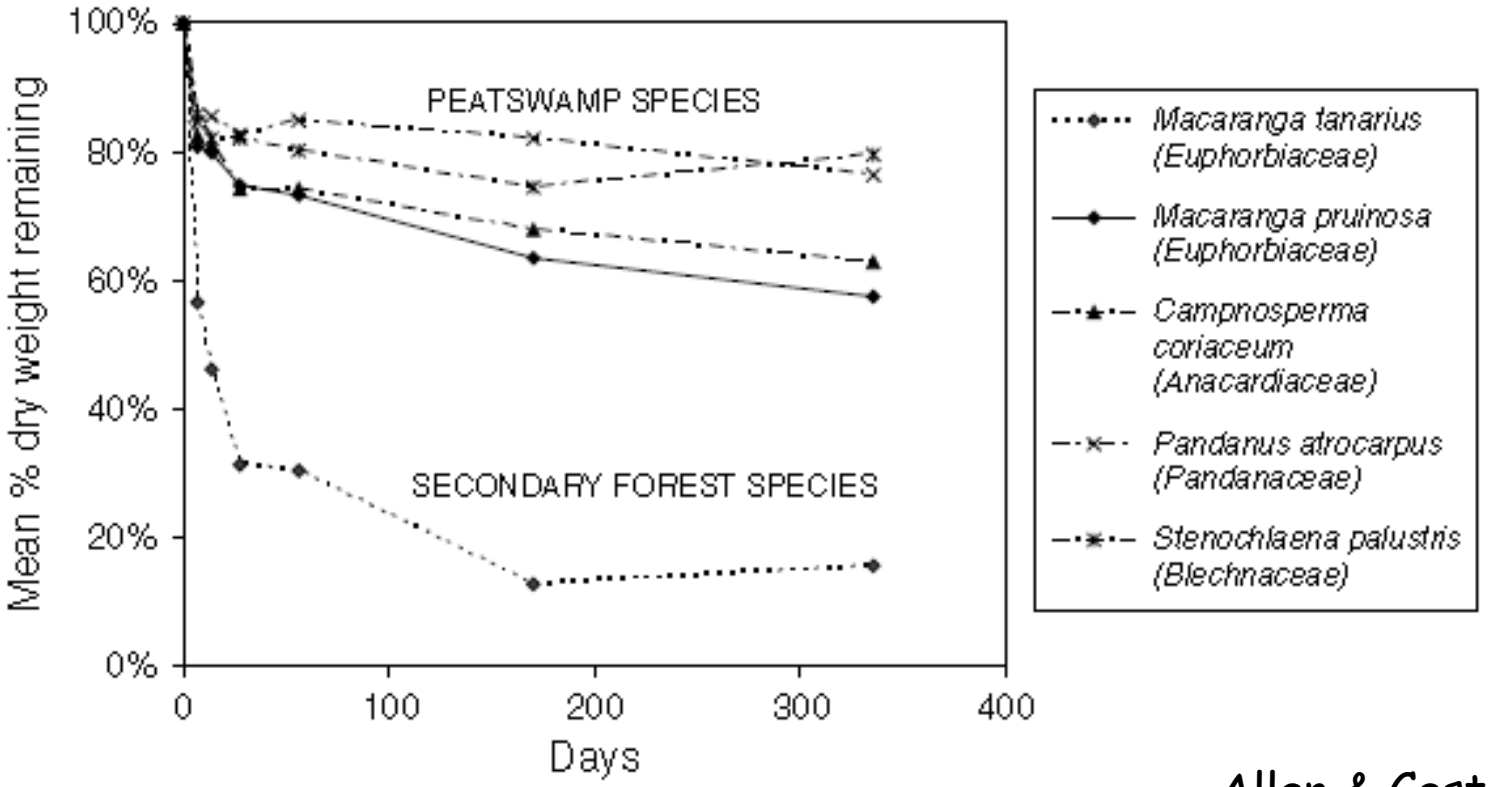
$$\frac{g(t)}{g(0)} \simeq \left\langle e^{-kt} \right\rangle = \int_0^\infty p(k) e^{-kt} \mathrm{d}k.$$

# Tropical Colombian STREAM

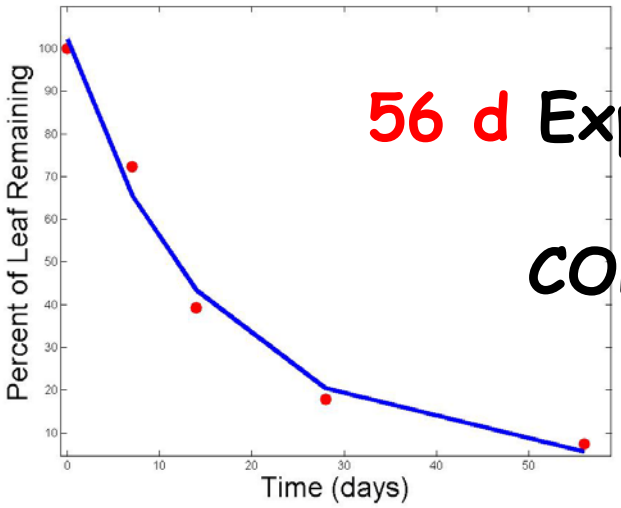



Zuñiga et al., (unpublished observations)

# Tropical Malaysian SWAMP

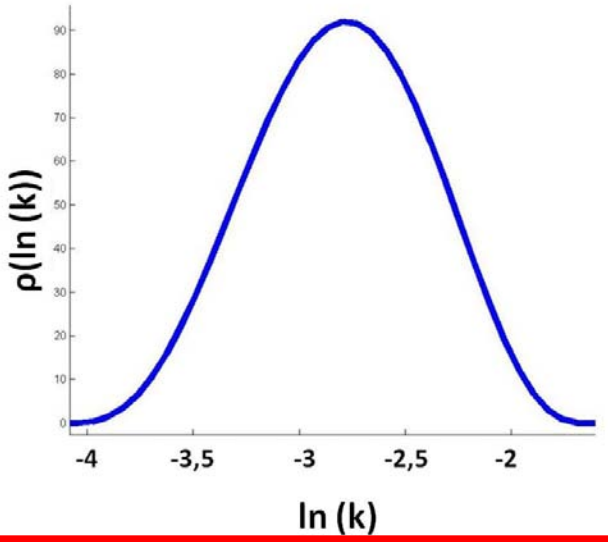


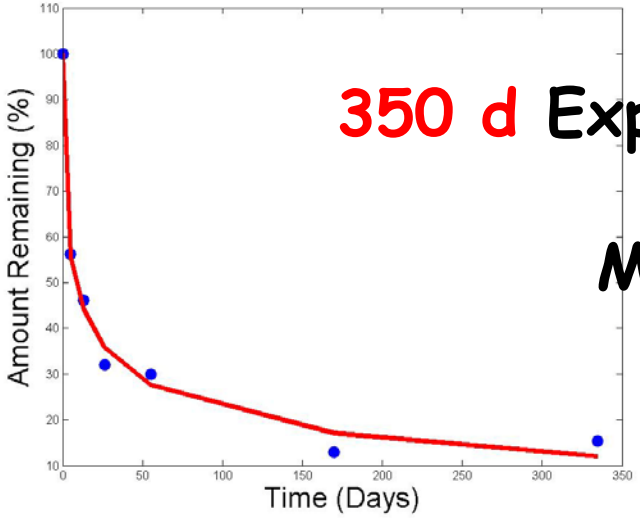

Allan & Castillo, 2007




## 56 d Experiment

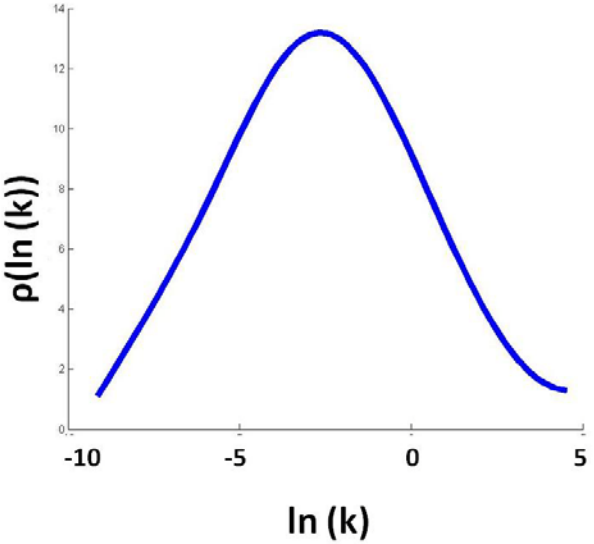
## COLOMBIA




## 350 d Experiment

## MALAYSIA



# Transient Problem

- The Survival Function is the inpulse response of the system

$$S(t) = \int_{k\min}^{k\max} \Lambda(k, \mu, \sigma) e^{-kt} dk$$

- The transient dynamic is obtained through convolution

$$g(t) = \int_{0}^{t} J(\tau) S(t - \tau) d\tau$$

# Input Function and Parameters

- $\mu$ = -2.75

gives a median decay rate of 1/15 day$^{-1}$

- $\sigma$ = 2.0 / 3.5 / 5 St.Dev of the logarithm of decay rates

- Input Function

A = 2.7 gC/m^2/d

T = 365 days

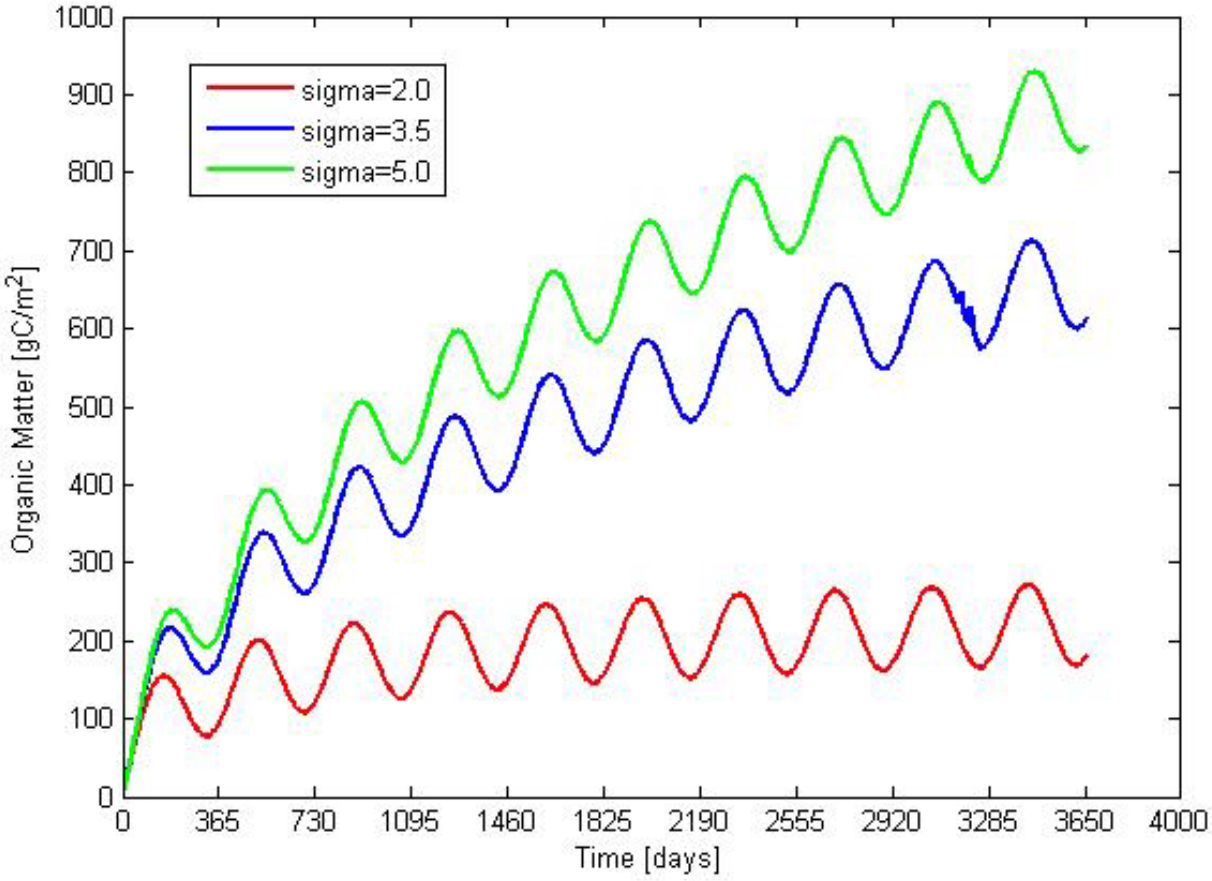
$$J(t) = A\left(\sin\left(\frac{2\pi}{T}t\right)+1\right)$$

# Results

Influence of σ to:

- size of the pool at steady state

- the length of the transient phase



# CONCLUSIONS:

- We applied the Disordered Kinetics approach to problems of litter decay in freshwater systems;

- The lognormal function seems to describe well the decay rates of this process;

- We studied also the transient dynamics in relationship with different shapes of the lognormal function.

## THANK YOU FOR THE ATTENTION!