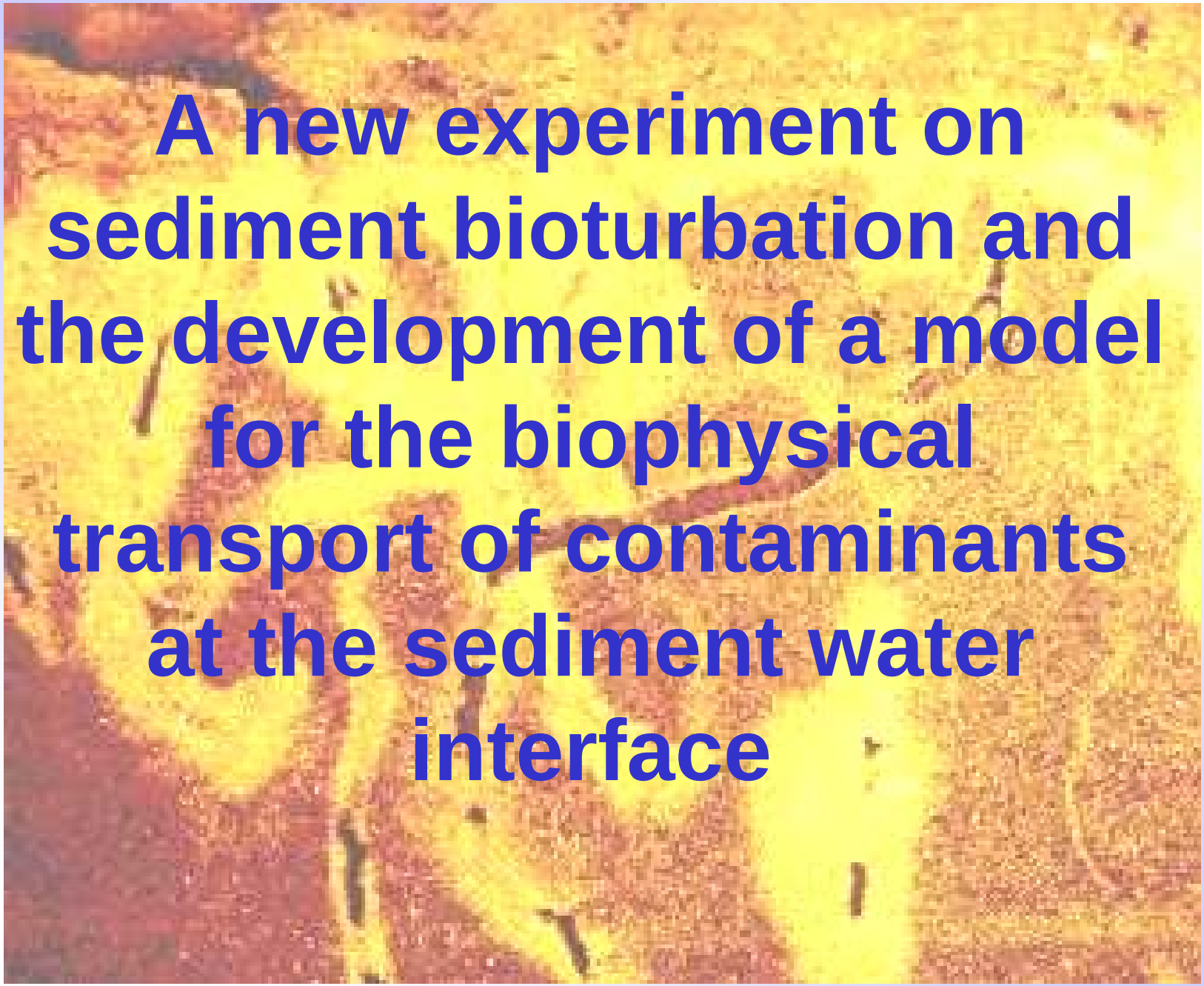
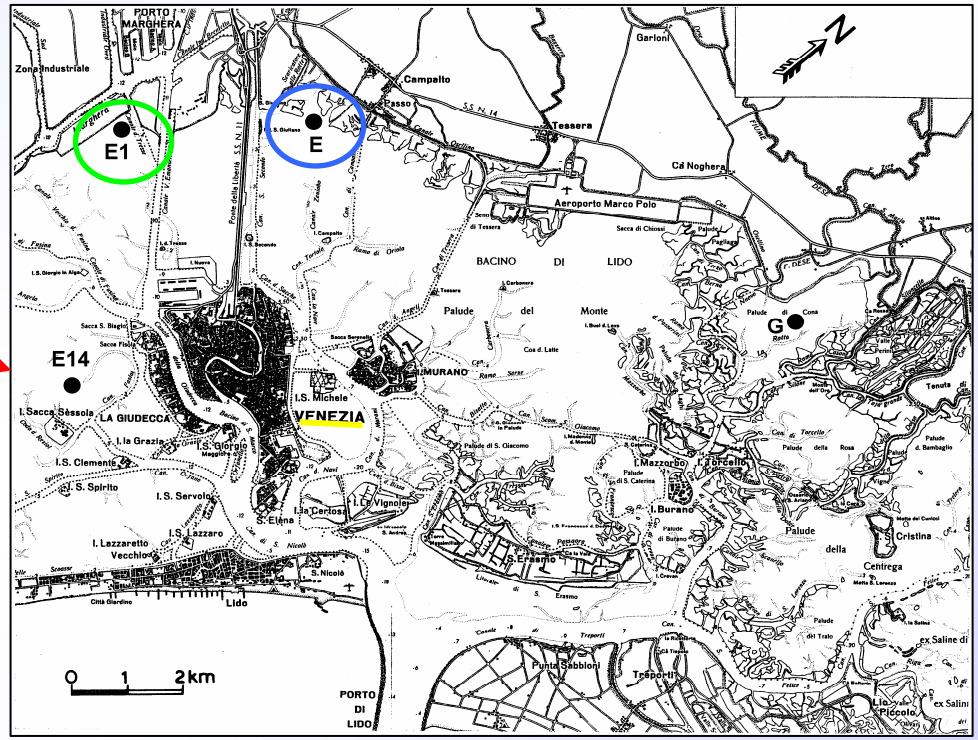

A new experiment on sediment bioturbation and the development of a model for the biophysical transport of contaminants at the sediment water interface

Study Area

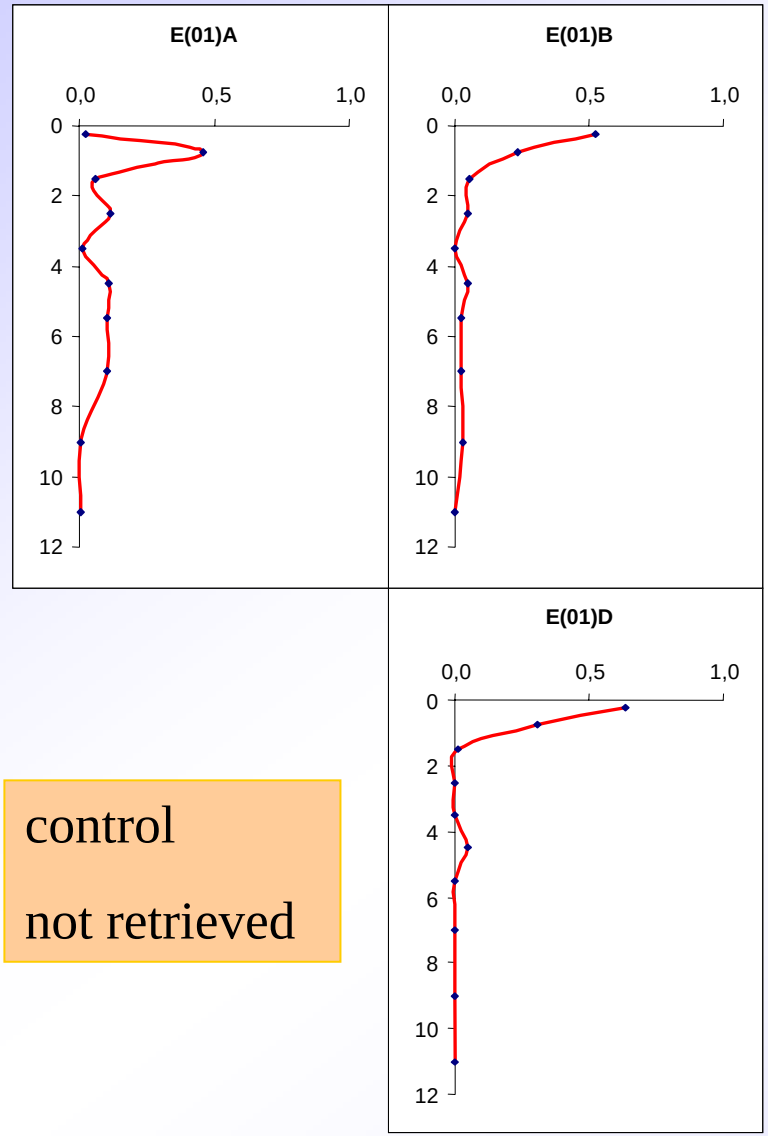

PORTO MARGHERA
Zona Industriale
E1
E
Campalto
Tessera
Ca' Noghera
Aeroporto Marco Polo
BACINO DI LIDO
Palude del Monte
E14
MURANO
I.S. Michele
VENEZIA
I. Sacca Sessola
LA GIUDECCA
I. la Grazia
I.S. Giorgio Maggiore
I.S. Clemente
I. S. Spirito
I. S. Servolo
S. Elena
I. Lazzaretto Vecchio
I.S. Lazzaro
Lido
I. Mazzorbo
Burano
I. Burano
Palude della Centrega
S. Cristina
Punta Sabbioni
Treporti
PORTO DI LIDO
0 1 2km

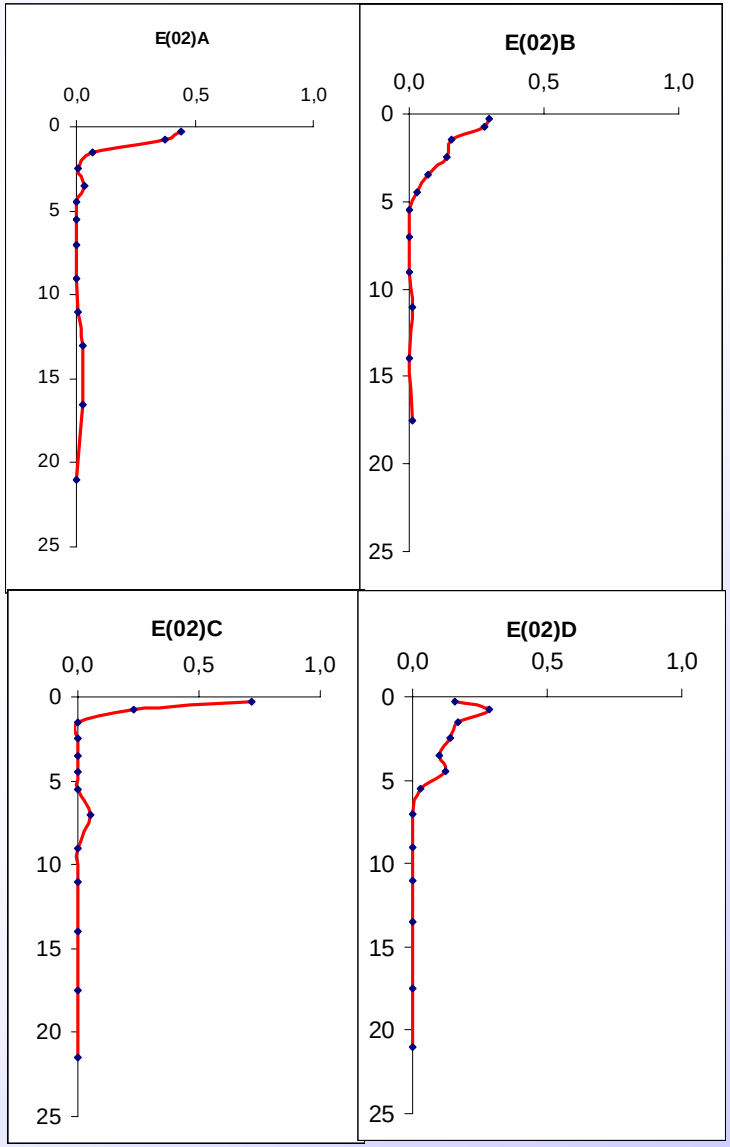
Site E

2001

2002

cm





control

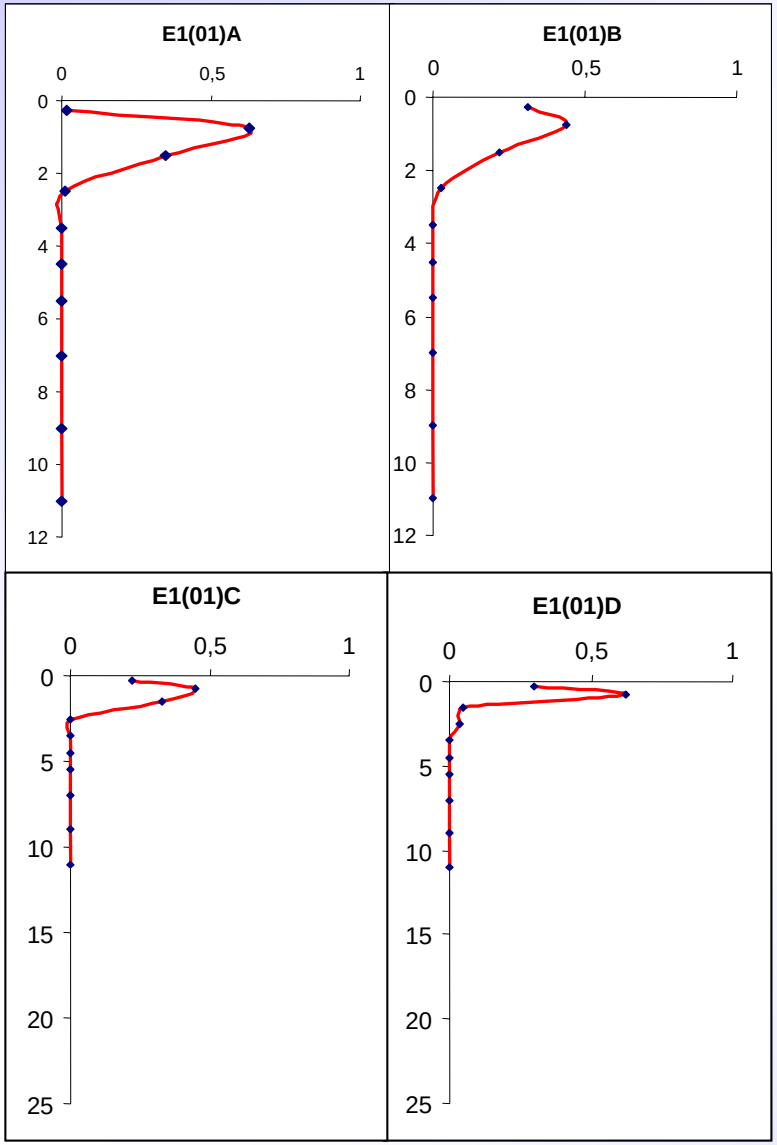
not retrieved

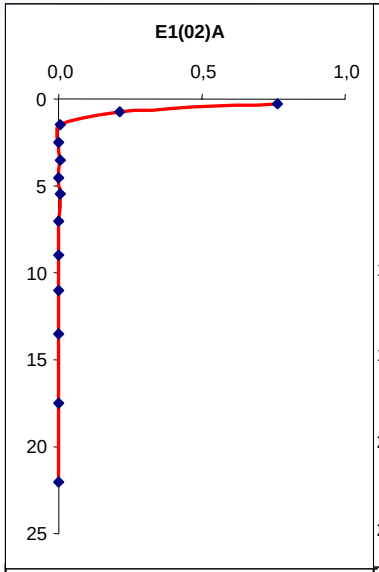
Site E1

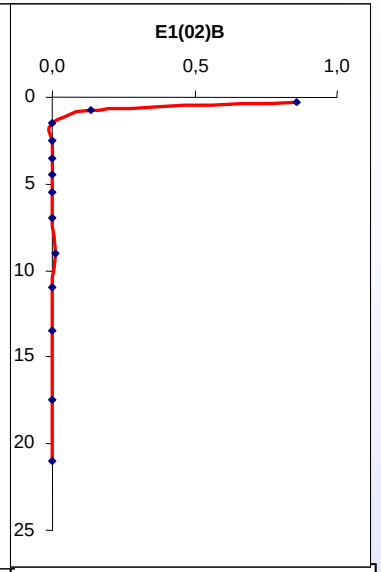
2001

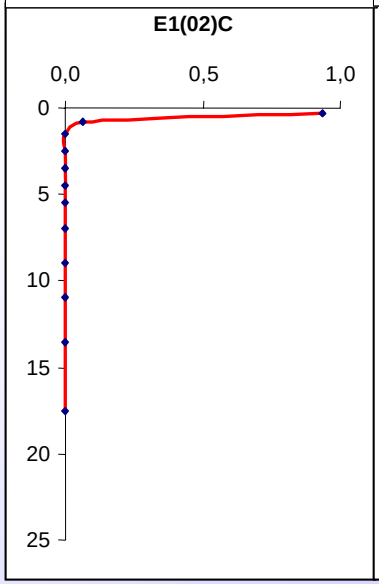
2002

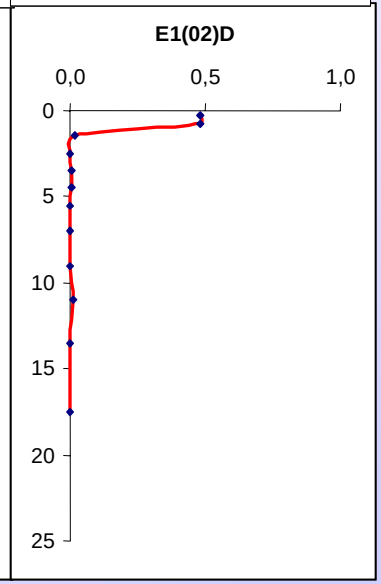
cm











Modeling the bio-physical transport at the water-sediment interface:

case of metallic contaminants

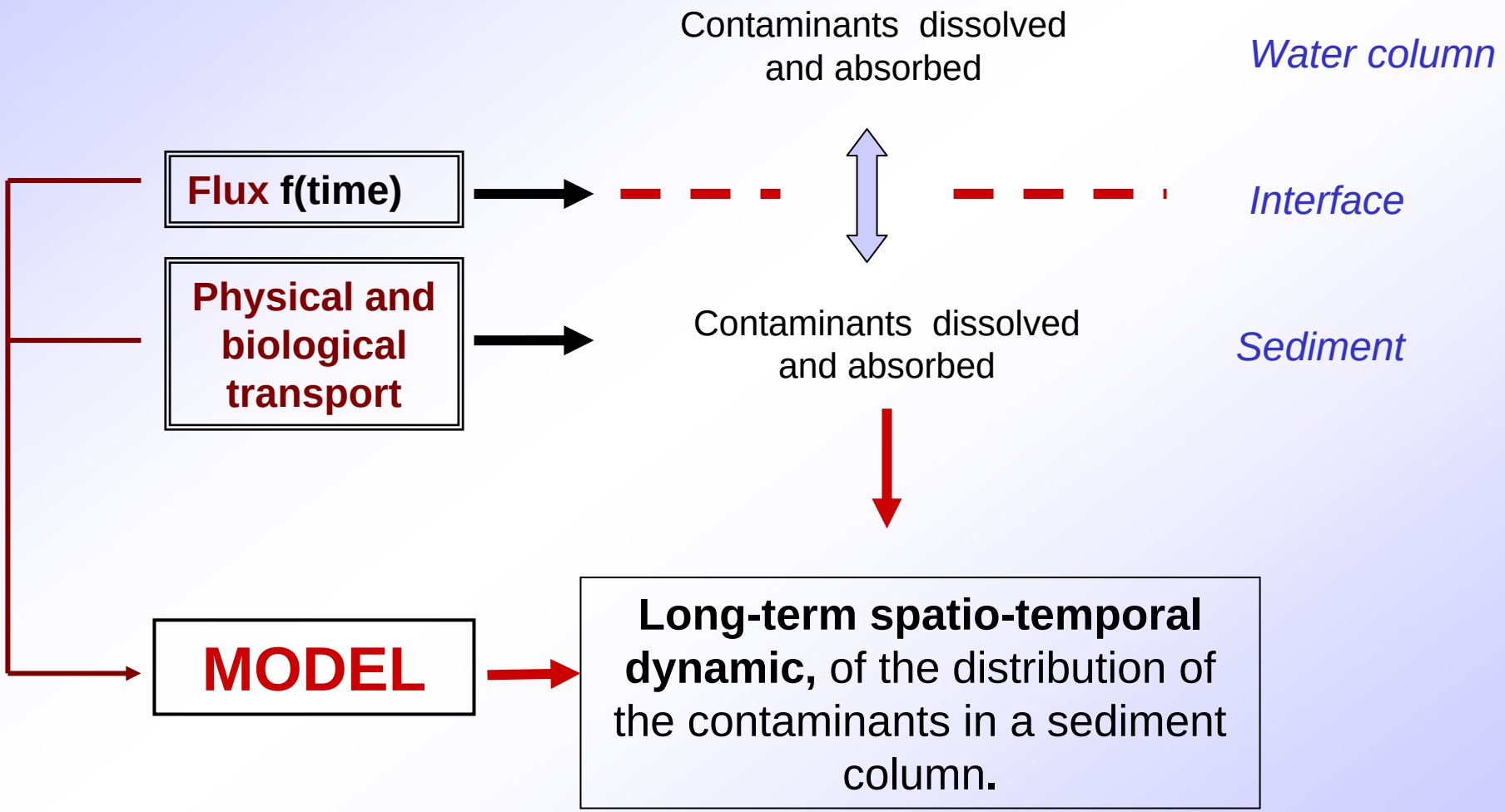
General steps

1- What are the goals of the model?

2 - What are the phenomena to be taken into account?

3 – How to construction the model?

Goals of the model



Identification of the processes to be included

- The physical processes.

- The biological processes.

- The reactions of adsorption-desorption of contaminants.

The physical processes

• The molecular diffusion : it affects the dissolved fraction of the tracer.

It can be explained by the FICK's law of diffusion. It describes the evolution of the concentration at a given depth with respect to the time:

$$\delta C / \delta t = Dm \cdot \delta^2 C / \delta z^2$$

with Dm = coefficient of diffusion

The physical processes

• The **advection** **due to the sedimentation** : it affects the dissolved and particulate fraction of the tracer, and corresponds to a burying.

It can be described by the equation:

$$\delta C / \delta t = -w . \delta C / \delta z$$

with w = burying velocity due to sedimentation

The biological processes

• The **biodiffusion** : it affects the dissolved and particulate fractions of tracer.

It explains the biological mixing of sediment, that lead to diffusion of tracer.

It results in the FICK law of diffusion:

$$\delta C / \delta t = Db \cdot \delta^2 C / \delta z^2$$

with Db = biodiffusion constant

The biological processes

• The **bioadvection** : it affects the dissolved and particulate fractions of tracer.

It corresponds to the ejection at the surface of the sediment particles ingested in depth by the organisms, that generates a burying of the tracer present at the surface .

It results with the following equation:

$$\delta C / \delta t = -u . \delta C / \delta z$$

with u = velocity of burying due to bioadvection

Biological processes

• The non local transport: it affects the particulate fraction of tracer.

It corresponds to the transfer of tracer to depth, due to the ingestion and the defecation of the organisms, or to the fall of tracers into the burrows.

• The convoying: it affects the particulate fraction of the tracer.

It corresponds to the ejection of tracer ingested at depth at the surface, and generates a flux of convoying at the sediment-water interface.

Synthesis

• The models of diffusion-advection are well known, and can be summarized as follows:

$$\delta C / \delta t = (Dm + Db) . \delta^2 C / \delta z^2 - (w + u). \delta C / \delta z$$

with

Dm = molecular diffusion coefficient

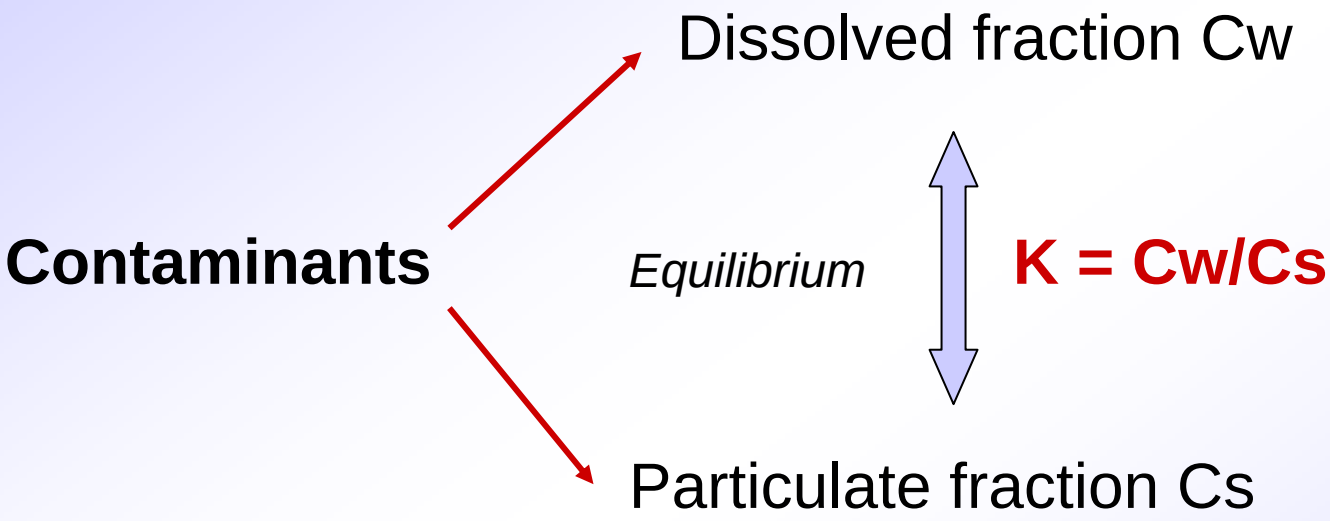
Db = biodiffusion coefficient

w = velocity of sedimentation

u = velocity due to bioadvection

• The phenomena of non local transport and convoying have been less modeled.

Identification de la forme des contaminants



Steps for the construction of the model

• **Modéliser** le phénomène de convoyage sur les données expérimentales « Microsphères », en l'intégrant dans un modèle Diffusion-Advection

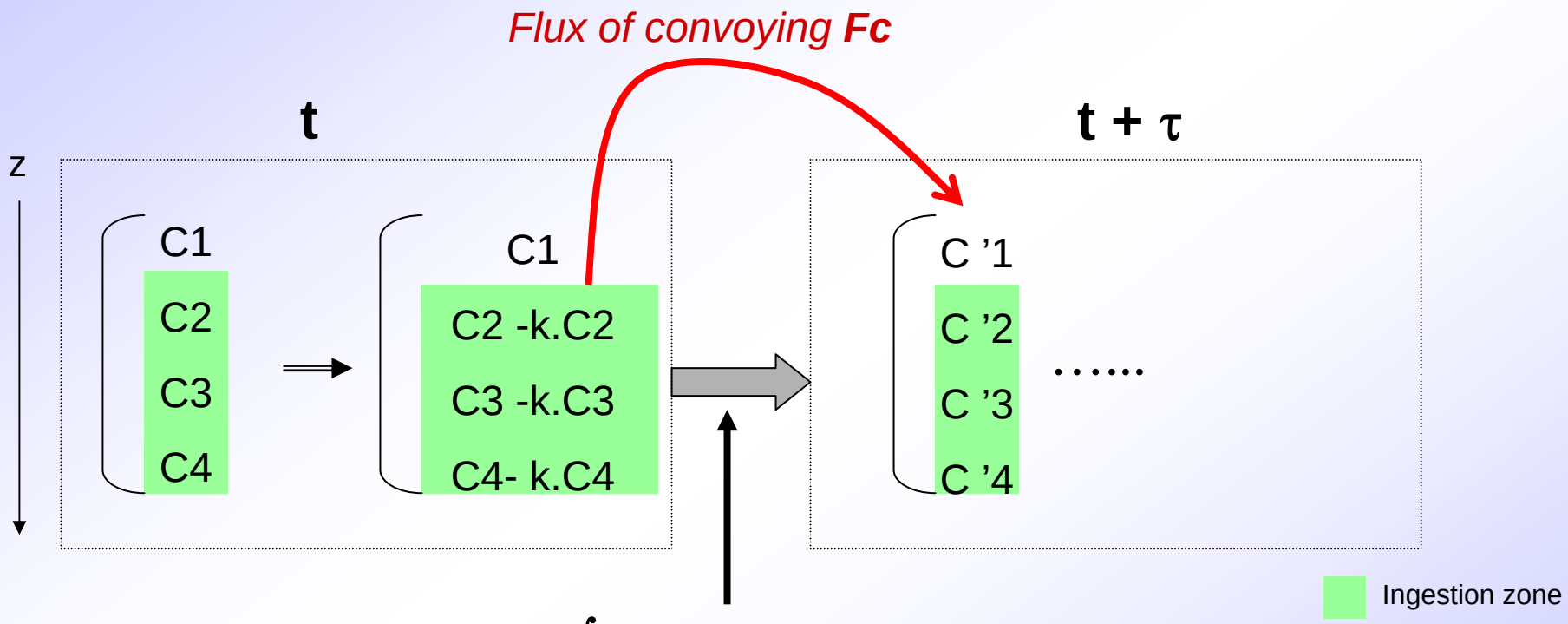
• **Adapter** ce modèle aux contaminants métalliques, en intégrant les phénomènes d 'adsorption-désorption, sur les données expérimentales Cadmium

• Adjoindre à ce modèle le transport non local, le **calibrer** sur les données « Venise »

• **Valider** ce modèle sur la retenue de Malause, suite à une campagne de mesure de bioturbation

Modelling the convoying

Principle of working



$$C(z,t) = \int^{t} Fc(\tau).c^{*}(z,t-\tau).d\tau$$

C* (z, t) = solution of the Diffusion-Advection model (known)

K = *constant of ingestion* = w / (z4 - z2)

Fc = *Flux of convoying* = k.(C2.dz2 + C3.dz3 + C4.dz4)