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Link between the hydraulic and morphological variability and the biodiversity on the Venoge River

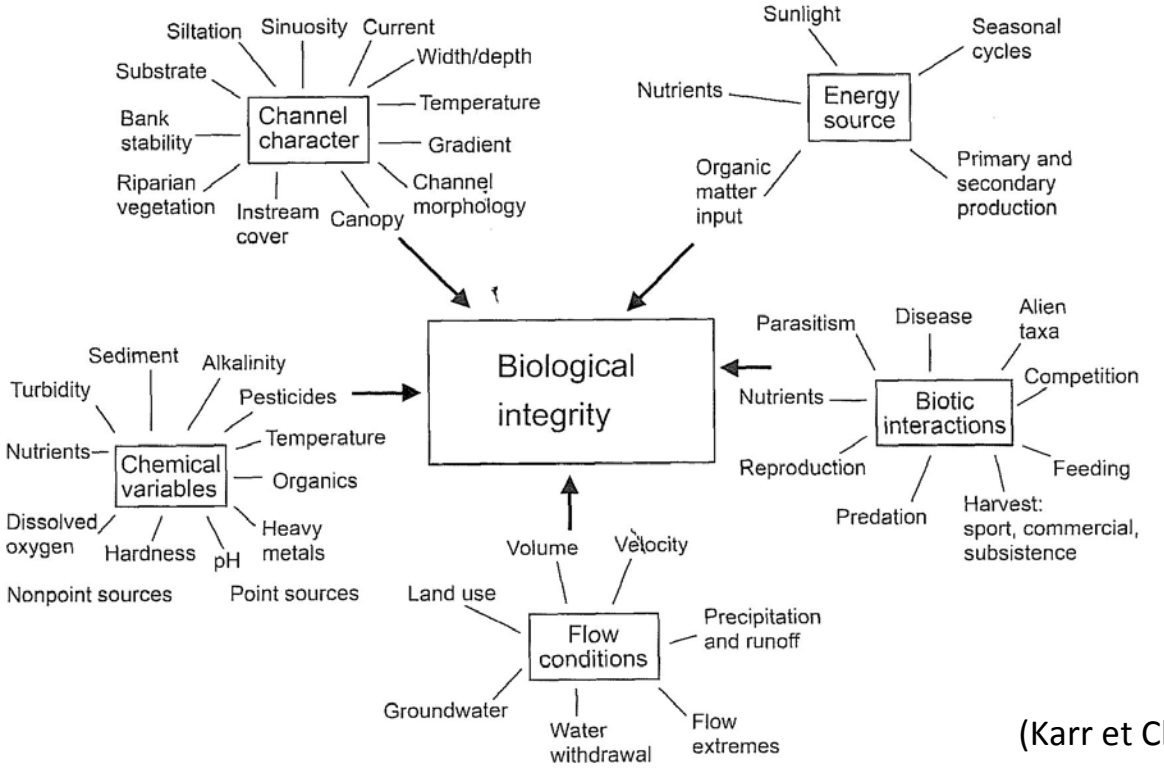
Candidat : Laura VIGNE

Professeur : Anton SCHLEISS

Assistant : Walter GOSTNER

Project description

AIM : Find a link between the hydraulic and morphological variability and the biodiversity on the Venoge River

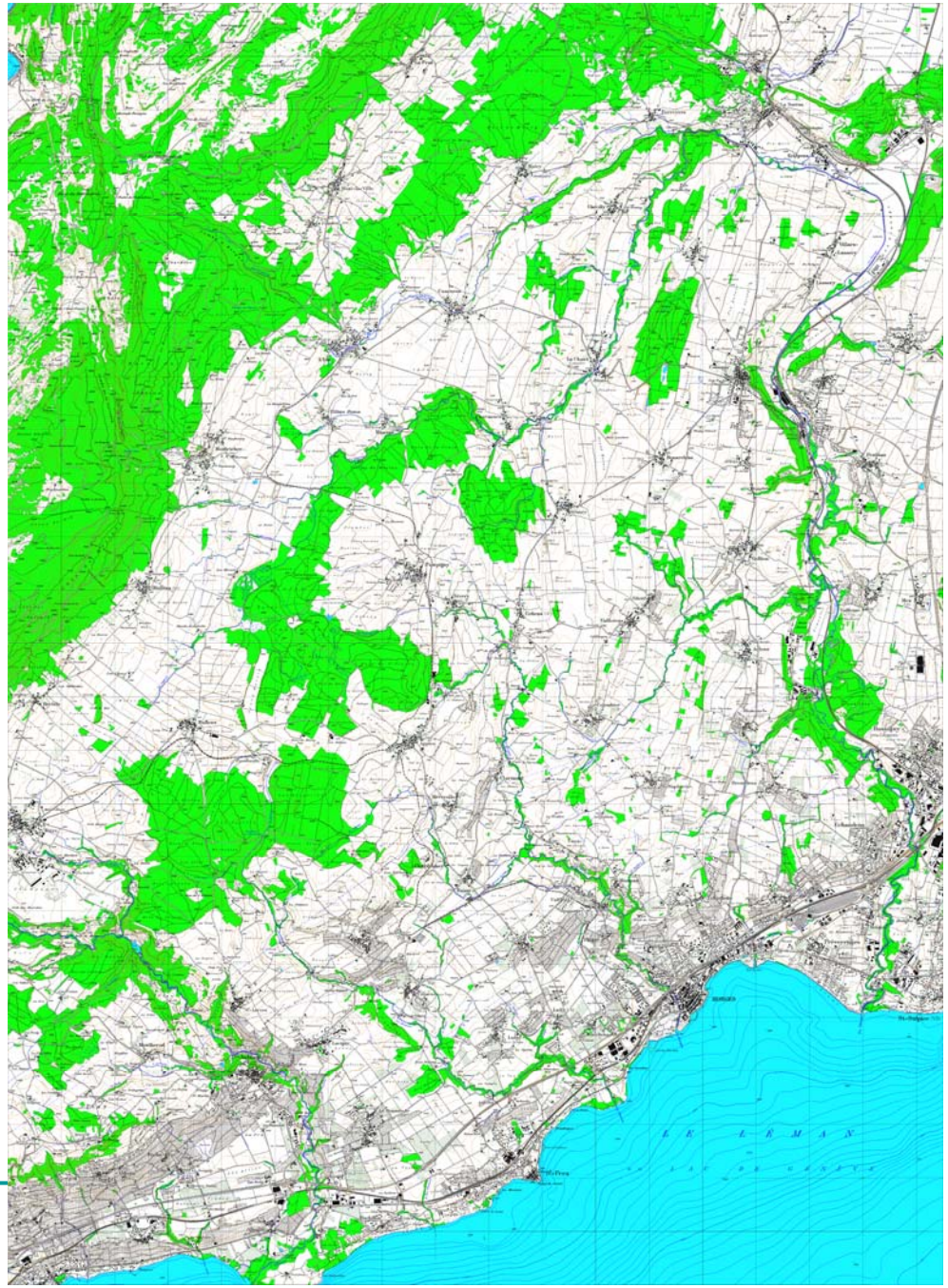


(Karr et Chu, 2000)

The Venoge River

Canton de Vaud

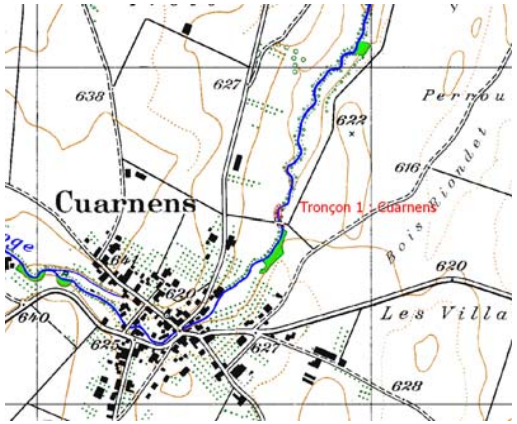
- Morphological characteristics very different along its course
- Several points for measuring biodiversity



Choice of 4 sites

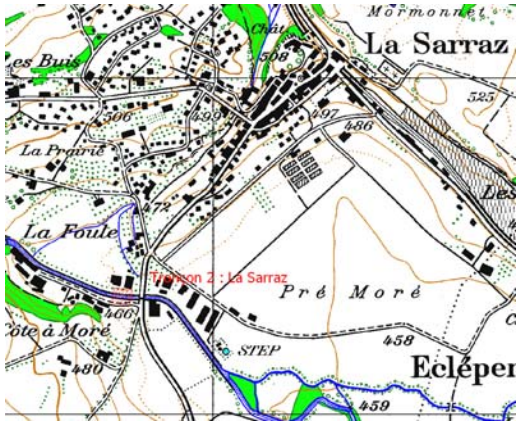
Criteria : different morphological characteristics
located near a measure point of biodiversity

The unit rates of flow are the same for the four studied sites, thus the hydrological parameters of these four sites can be compared.



Site 1 : Cuarnens

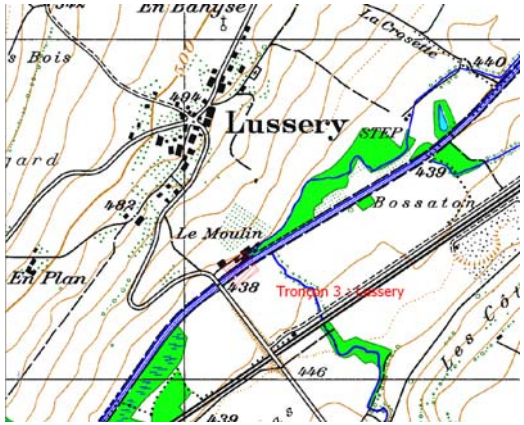
Morphology
Close to natural state: Banks protected locally.
Medium slope, track almost straight.
Length of the section : 60 m
Average width : 4.6m
Geographical location Coord : 523 723 ; 164 560
Close to purification station of Cuarnens. Rural environment



Site 2 : La Sarraz

Morphology
Canalized section, trapezoidal channel , straight
Length of the section : 40 m
Width : ≈ 7m
Geographical location Coord : 528 730 ; 167 350
Location of the RIVAUD station of La Sarraz
Semi- rural environment

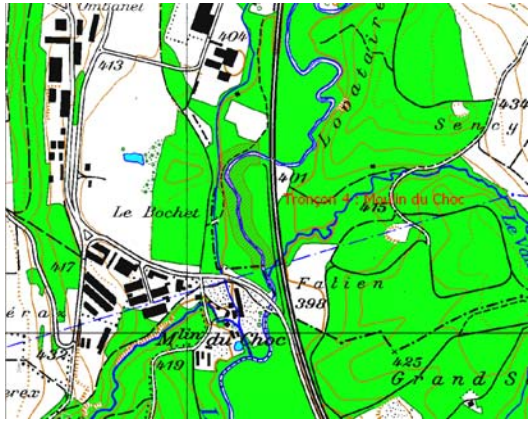
Choice of 4 sites



Site 3 : Lussery

Morphology
Canalized section, trapezoidal channel , straight
Length of the section : 80 m
Width : ≈ 6.9m

Geographical location Coord : 530 300 ; 164 410
Location of the RIVAUD station of Lussery
Rural environment



Tronçon 4 : Moulin du Choc

Morphology
Natural meanders, gentle slope
Length of the section : ≈ 120 m
Average width : 13.5 m
Geographical location Coord : 530 240 ; 157 130
Location of the RIVAUD station of Moulin du Choc
Forest area

Measures

Water depth and flow velocity have been measured for each parts of the river.

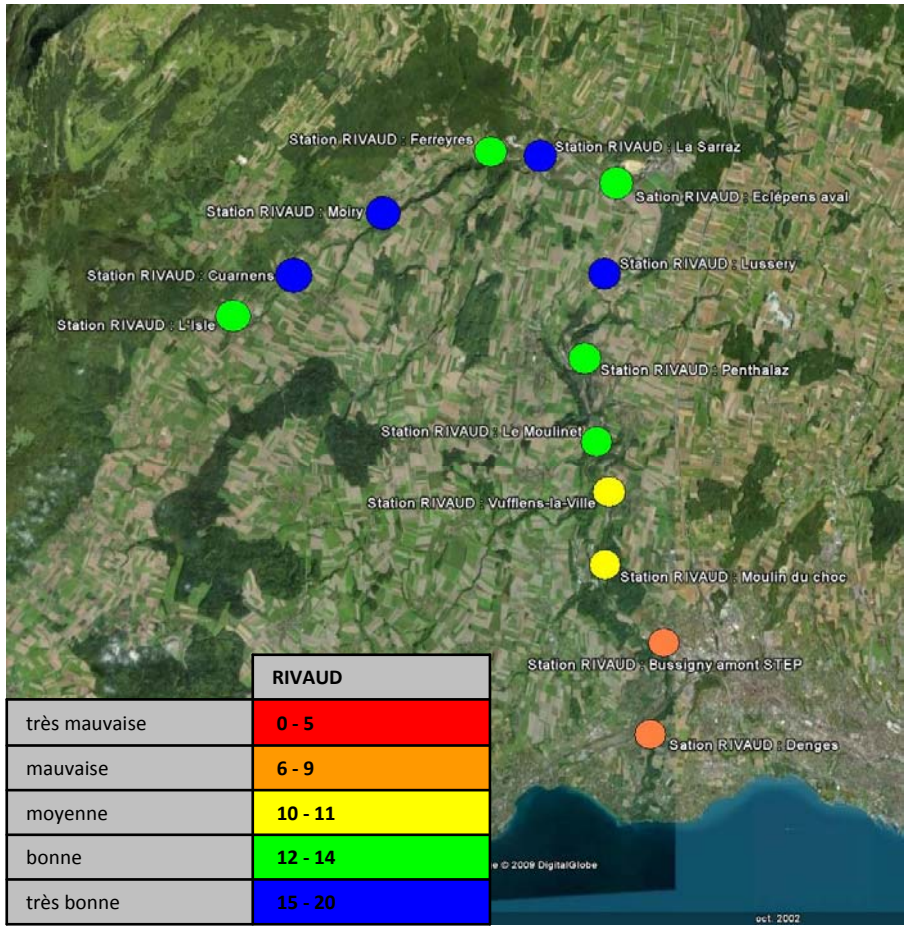
The interval between each measure has been chosen according to the morphological variability of the section.

	Number of transverses sections[m]	Interval between transverse sections[m]	Interval between measures [m]
Site 1 : Cuarnens	12	5	0.5
Site 2 : La Sarraz	8	5	0.5
Site 3 : Lussery	8	10	0.5
Site 4 : Moulin du choc	12	>10	1

Statistical analysis

Parameters		Site 1 Cuarnens	Site 2 La Sarraz	Site 3 Lussery	Site 4 Moulin du Choc
Water depth	Average [m]	0.298	0.315	0.439	0.491
	Standart dev. [-]	0.164	0.077	0.144	0.262
Velocity	Average [m/s]	0.454	0.793	0.766	0.570
	Standart dev. [-]	0.390	0.164	0.313	0.335
Width	Average [m]	4.592	9.600	7.013	13.533
	Standart dev. [-]	0.869	0.120	0.083	3.945
Froude number	Average [-]	0.273	0.462	0.360	0.278
	Standart dev. [-]	0.227	0.104	0.136	0.175
Ratio v/h	Average [s^{-1}]	1.752	2.714	1.706	1.485
	Standart dev. [-]	1.660	1.081	0.728	1.248

Biological quality of the Venoge River



RIVAUD	
très mauvaise	0 - 5
mauvaise	6 - 9
moyenne	10 - 11
bonne	12 - 14
très bonne	15 - 20

RIVAUD index, 2006 (source image : modifié de google earth)

The RIVAUD Index :

(Lang, Reymond, 1995)

- Based on the diversity of benthic fauna
- from 0 to 20; 0 means there is no alive organism leaving in this river and 20 means the biological quality is perfect.

RIVAUD index of the studied sections (2006)

Source : SESA

Sites	RIVAUD Index 2006 (max : 20)	RIVAUD index 2006 normalized (max : 1)
Cuarnens	18	0.9
La Sarraz	16	0.8
Lussery	17	0.85
Moulin du Choc	11	0.55

Ecomorphology

The ecomorphology of a river is the qualitative image of the hydraulic and morphological conditions. Establishing a relation between the results of the evaluations and the biologic quality of water allows deducting one simple manner the role of the hydraulics and morphological conditions on the diversity.

USEPA habitats assesments (United States Environmental Protection Agency)
(Barbour, 1999)

- Based on in-situ visual observations
- Each section is noted, depending on several criteria.
- One note is given to each criteria, then the notes of the criteria are summed up.
- Two different series of criteria are evaluated. one for high gradient stream the other for low ones.

USEPA habitat assessment Criteria

Criteria	
High gradient stream	**Low gradient stream**
Epifaunal substrate / available cover	Epifaunal substrate / available cover
embededdness	pool substrate characterization
Velocity/depth combinaisons	Pool Variability
Sediment deposition	Sediment deposition
Channel flow status	Channel flow status
Channel alteration	Channel alteration
Frequency of riffles	Sinuosity
Bank stability	Bank stability
Bank vegetative protection	Bank vegetative protection
Riparian vegetative zone width	Riparian vegetative zone width

USEPA assessment

Results

	Note usepa (max : 200)	Note usepa normée (max : 1)
Cuarnens	168	0.84
La Sarraz	82	0.41
Lussery	94	0.47
Moulin du Choc	148	0.74

Comments

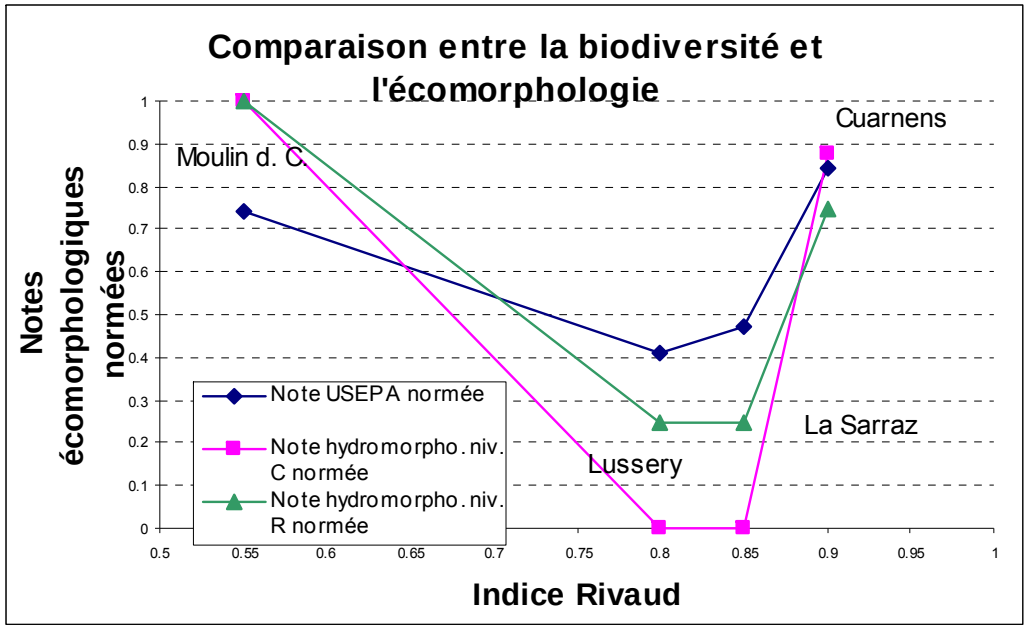
→ qualitative and subjective method, based on visual observations.

→ Accurate method : La Sarraz and Lussery differenciated

→ Questionnable criteria : stability..

Impact of hydraulic and morphological conditions and of chemical quality on the biodiversity

Link between biodiversity and ecomorphology



The RIVAUD index is not correlated with the ecomorphology of the Venoge.

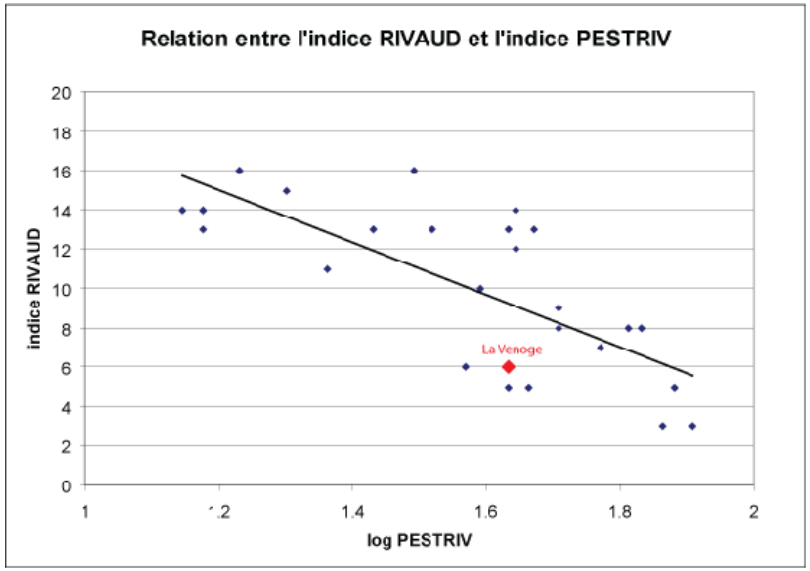
The canalized sections show a very good RIVAUD index .

→ Some of the hydromorphological parameters give to the canalized sections a good biologic quality and, thus, are not taken into account in the ecomorphology evaluation. Ex : siltation

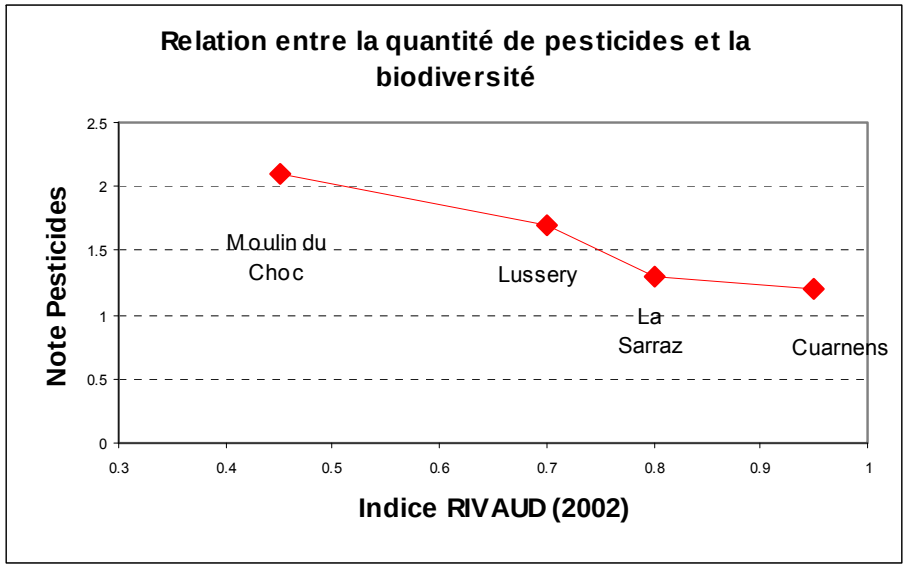
Moulin du Choc, which has a good ecomorphological quality, has a medium RIVAUD index.

→ Area damaged by another factor, the chemical quality of waters.

Link between the biodiversity and the chemical quality of water



Relation between the RIVAUD index (2000) and the log of the PESTRIV index for 26 rivers of the canton de Vaud. Lang et al. (2000).



Relation between the RIVAUD index (2002) and the sum of pesticides concentrations detected (campaign 2002-2004, SESA) in the 4 stations of the Venoge.

A very strong correlation exists between the RIVAUD index and the pesticides potency.

The correlation between the biodiversity and the hydraulic et morphological variability is very low, because of pesticides presence in the Venoge.

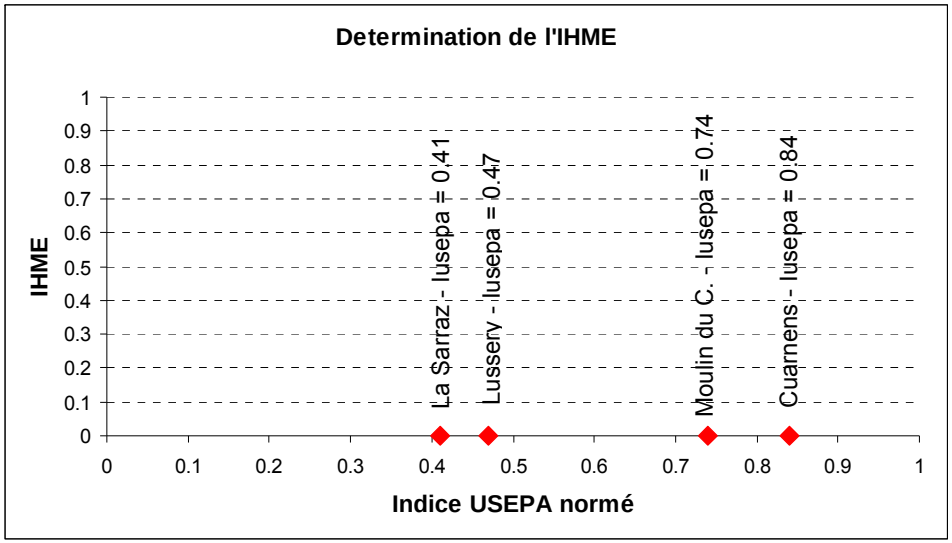
Link between the hydraulic and morphological variability and the ecomorphology

The relation between the hydromorphology and ecomorphology is modelized by an index. The hydromorphological ecomorphology index (IHME), grouping the different hydraulics and morphological parameters deducted from the measures done on the Venoge (flow speed, water height, width, Froude number, ratio v/h).
For each parameter, i, is associated a variability index, E(i).
The variability of each parameter is then included in a formula which gives a global index, IHME.
The result of the function is an ecomorphology indicator, the USEPA index.

$$IHME = f\left(E_a, E_b, E_c, \ldots\right) \leftrightarrow I_{USEPA}$$

The development of the IHME index

Several indexes are sequentially elaborated in order to approach the best possible correlation between IHME index and the normalized USEPA one.



The successive modifications of IHME index are oriented on two ways:

- Determination of the form of the variability index of parameters E,
- Selection of parameters having an impact on ecomorphology and determination of the formula which links the selected parameters variability E(i).

IHME

The index of hydraulic and morphological variability which shows the best correlation with ecomorphology of the Venoge is derived from the index developed by A, Schleiss (2005).

Variability index of parameters

$$E(i) = 1 + \frac{\sigma_i^2}{\mu_i^2}$$

Global variability index

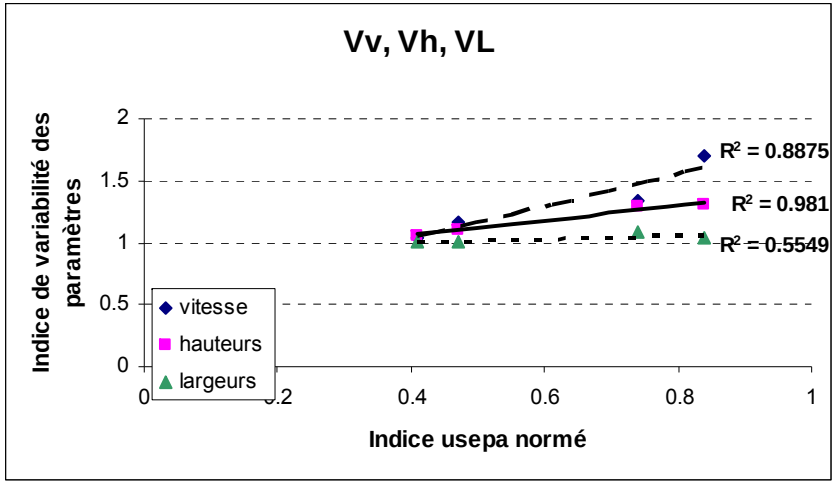
$$IHME = \prod_i E(i)$$

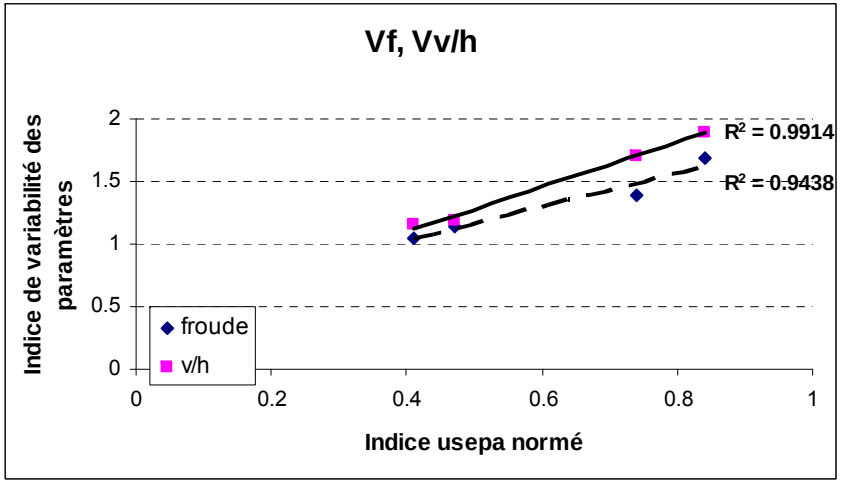
The variables of the function must be independents parameters.

IHME

Variability index of parameters

$$E(i) = V(i) = 1 + \frac{\sigma_i^2}{\mu_i^2}$$



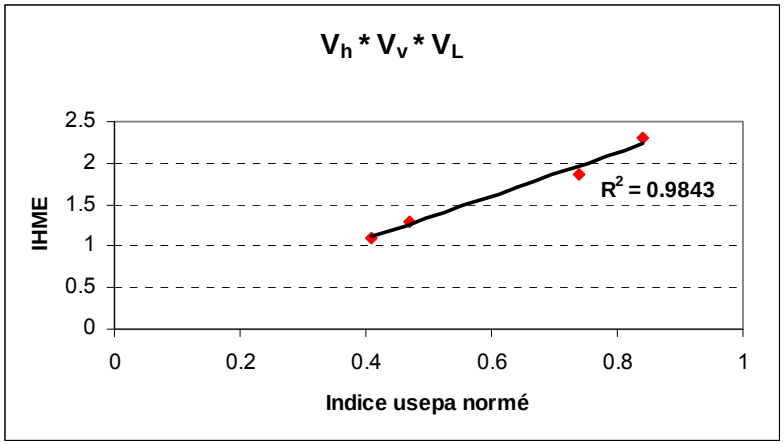


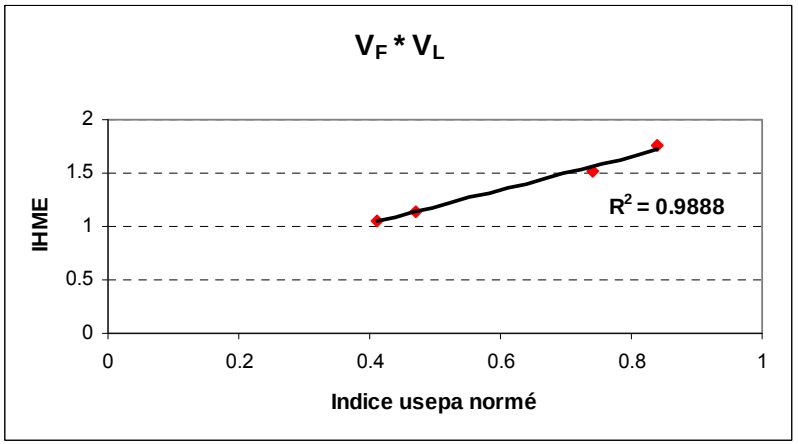
Variability index of parameters	R^2
V_V	0.89
V_h	0.98
V_F	0.94
$V_{v/h}$	0.99
V_L	0.56

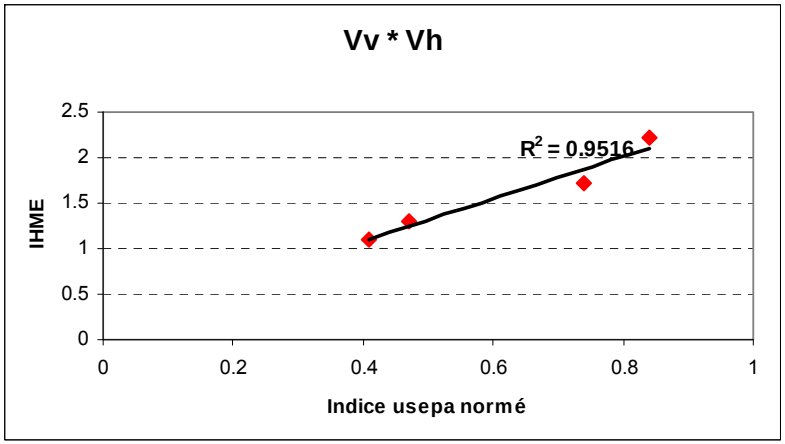
IHME

Global variability index

$$IHME = \prod_i V(i)$$







IHME	R^2
$V_v * V_h * V_L$	0.98
$V_v * V_h$	0.95
$V_F * V_L$	0.99

Method applied to the Buenz

In order to check the validity of this index, liking hydromorphology and ecomorphology, it has been applied to the Buenz.

(Walter Gostner data)

Site 1

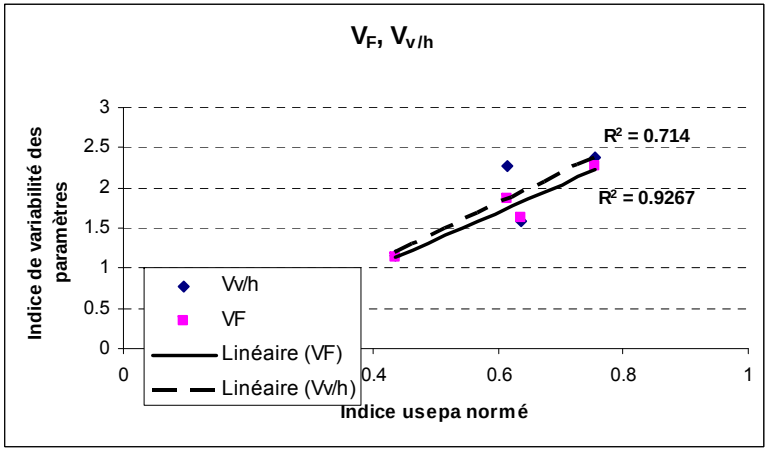
Site 2

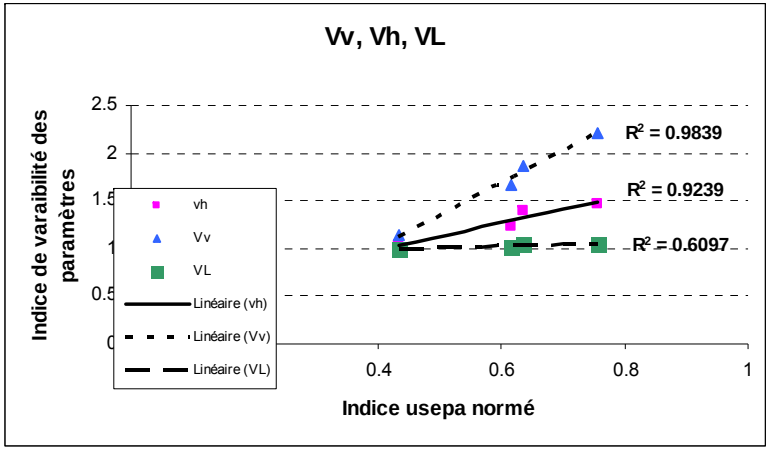
Site 3

Site 4

	Note USEPA normée
Site 1	0.635
Site 2	0.755
Site 3	0.435
Site 4	0.615

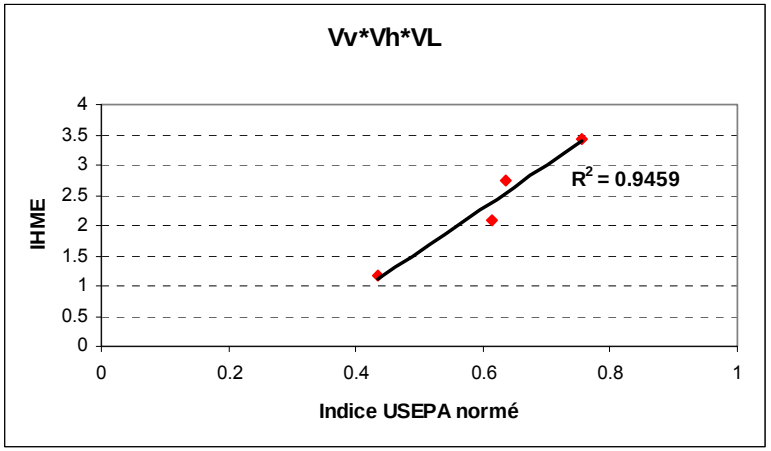
IHME - Variability index of parameters

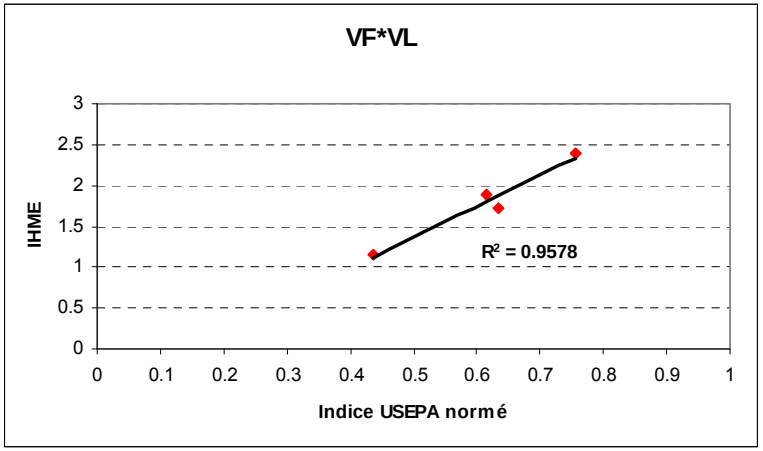




Indice de variabilité comorphologique des paramètres	R^2
Vv	0.98
Vh	0.92
Vf	0.93
Vv/h	0.71
VL	0.61

IHME - Global variability index





IHME	R^2
$V_v * V_h * V_L$	0.95
$V_F * V_L$	0.96

Comments and recommandations

Very good correlation between the IHME and the ecomorphology wich could be considered as a « potential of biodiversity »

future researches :

→ application of the IHME on rivers for which the water quality is not polluted by pesticides in order to be able to underline the role of the hydromorphological characteristics on the biodiversity and establish a link between these two characteristics.

→ collection of all the hydromorphological parameters which have an impact on the biodiversity

→ Definition of a new formula linking these parameters

=> univocal link between hydraulic and morphological parameters and biodiversity could be established.

Merci pour votre attention