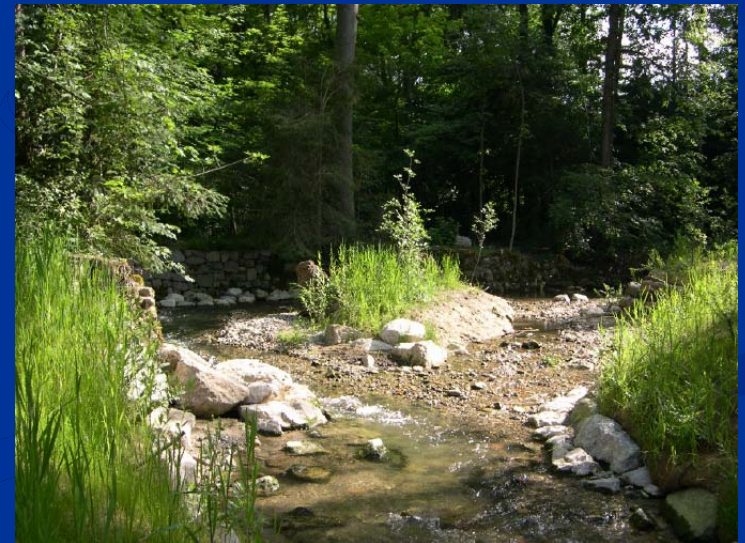


# A living environment, tiny but fundamental

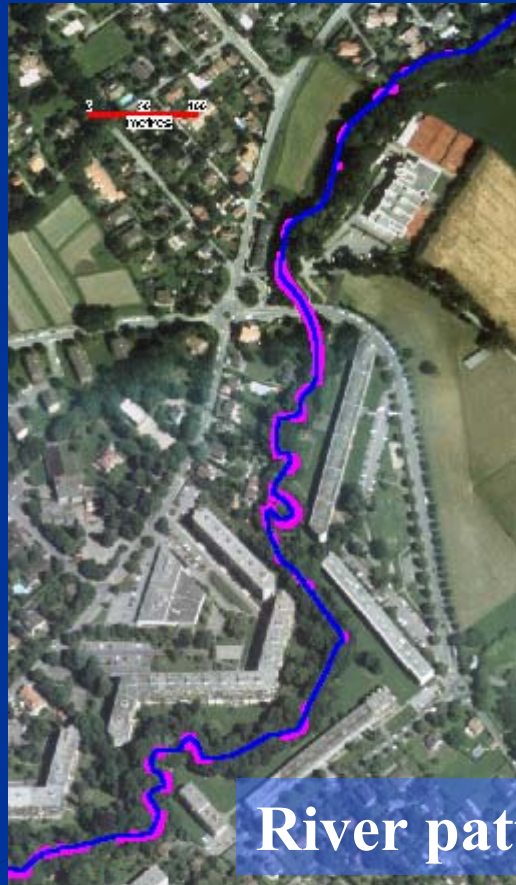
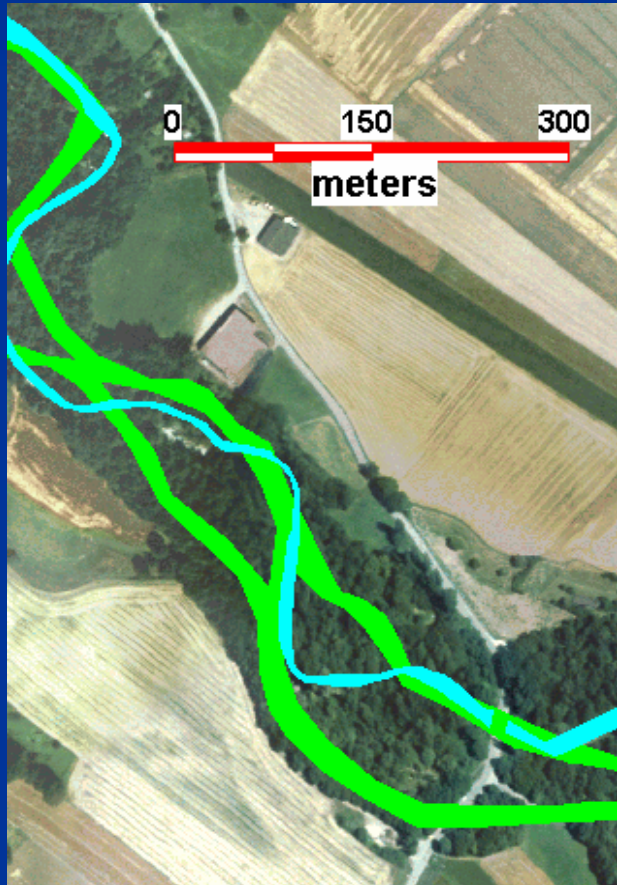


B+C Ingénieurs  
D. Consuegra



Département du territoire  
Direction générale de l'eau





# River patterns in Geneva



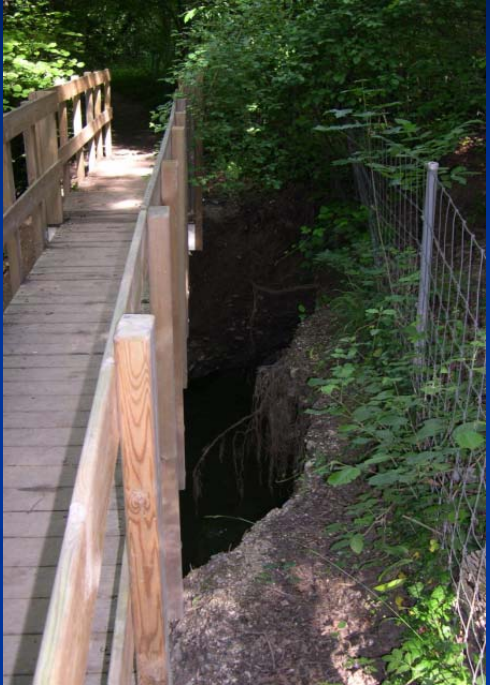


# Many threatened urban regions





# An increasing number of security conflicts



# Repeated and negative impacts of urban storm runoff



Rejets pluviaux



Colmatage des  
substrats



Rejets eaux mélangées

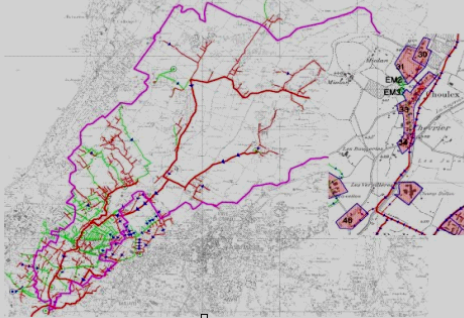


# Improve the diagnostics .. Long term simulation

Continuous series (10-20 years)

## Dry weather flow

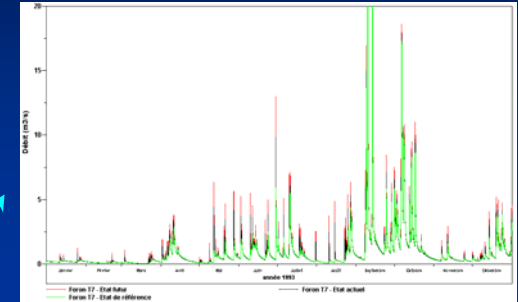
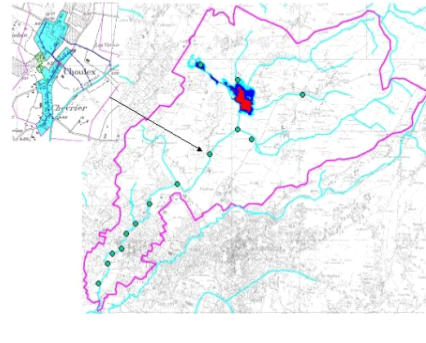
- Couche « eaux usées » : gère les eaux dont l'exutoire est le collecteur primaire STEP
- calcule les débits dans les réseaux unitaires et d'eaux usées séparatifs
  - simule le fonctionnement des déversoirs d'orage
  - modélise le débit de base de la rivière



## River flow and regime

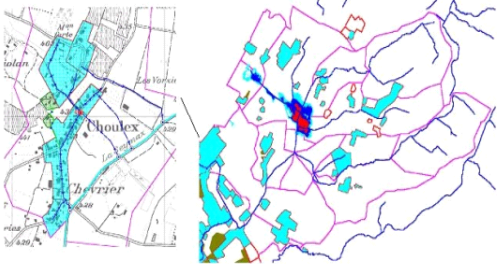
### Couche 3 : Rivière

- Couche « Rivière » :
- récolte les rejets pluviaux et les débits de base
  - permet le développement d'indicateurs

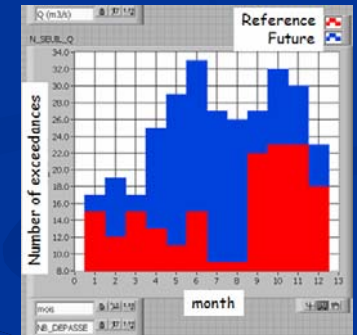


## Wet weather flow

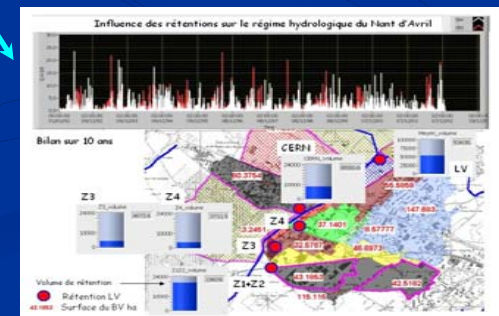
- Couche « rejets pluviaux » : gère toutes les eaux dont l'exutoire est la rivière
- permet le calcul des débits dans le réseau d'eaux pluviales
  - calcule le ruissellement de surface des bassins versants ruraux



## Indicators



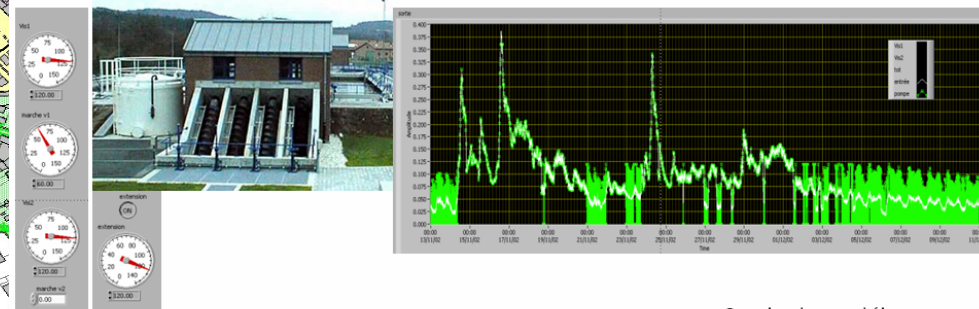
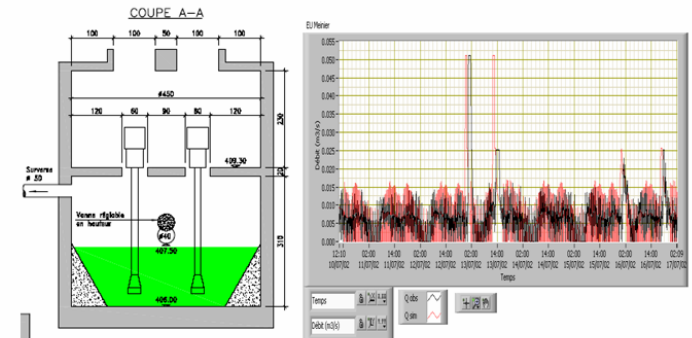
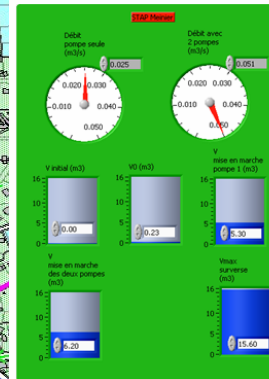
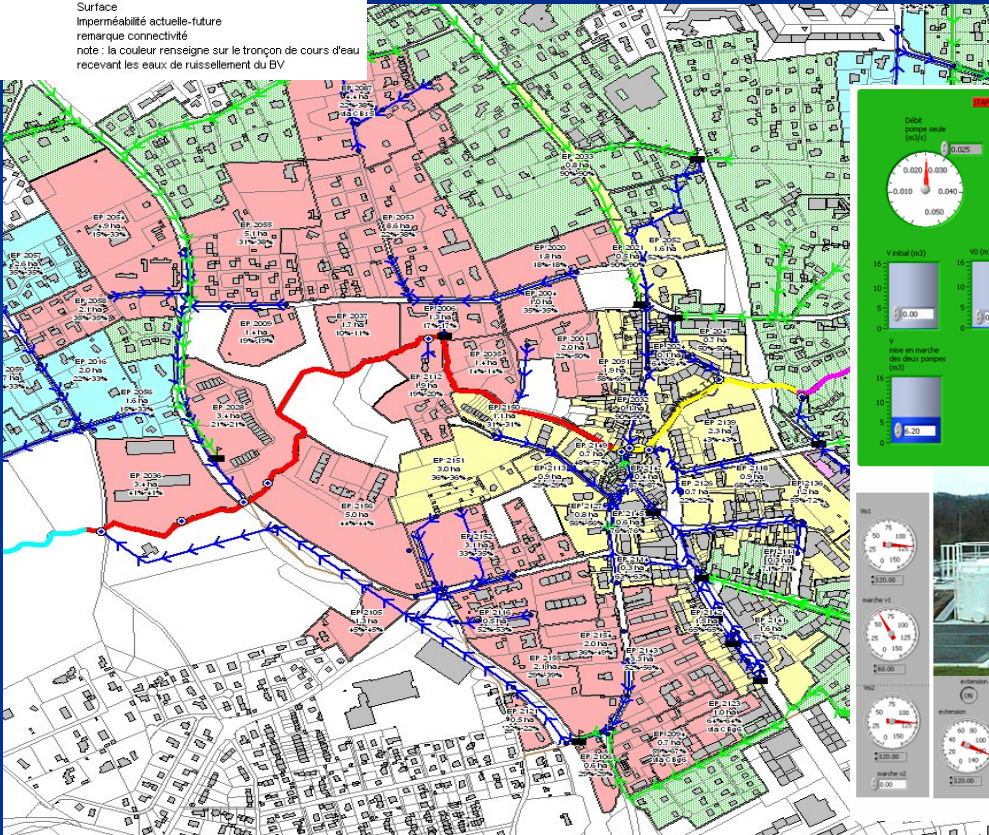
## Scenario analysis



## Légende

- ▣ Déversoir d'orage
  - ⊙ Point de rejet
  - Collecteur EM
  - Collecteur EP
  - ▭ Bassin versant EM
  - ▭ Limite communale
  - Tronçon de rivière à ciel ouvert
  - Tronçon de rivière souterrain
  - Regard EP
  - ▭ Bassin versant EP
- Nom du bassin  
Surface  
Imperméabilité actuelle-future  
remarque connectivité  
note : la couleur renseigne sur le tronçon de cours d'eau recevant les eaux de ruissellement du BV

# Model the catchment at an adequate scale



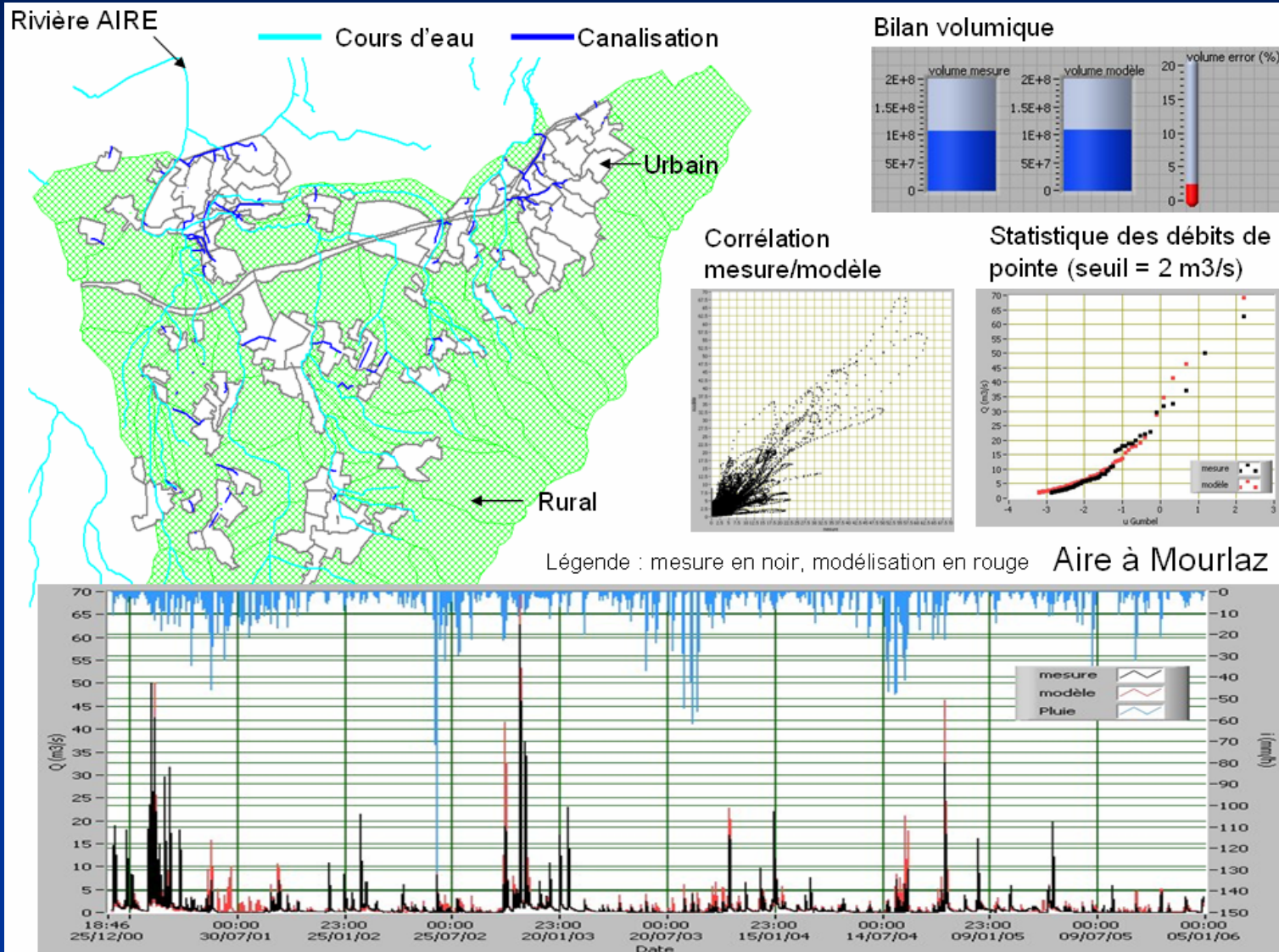
Outils de modélisation

## Detailed enough to analyse complex hydraulic structures



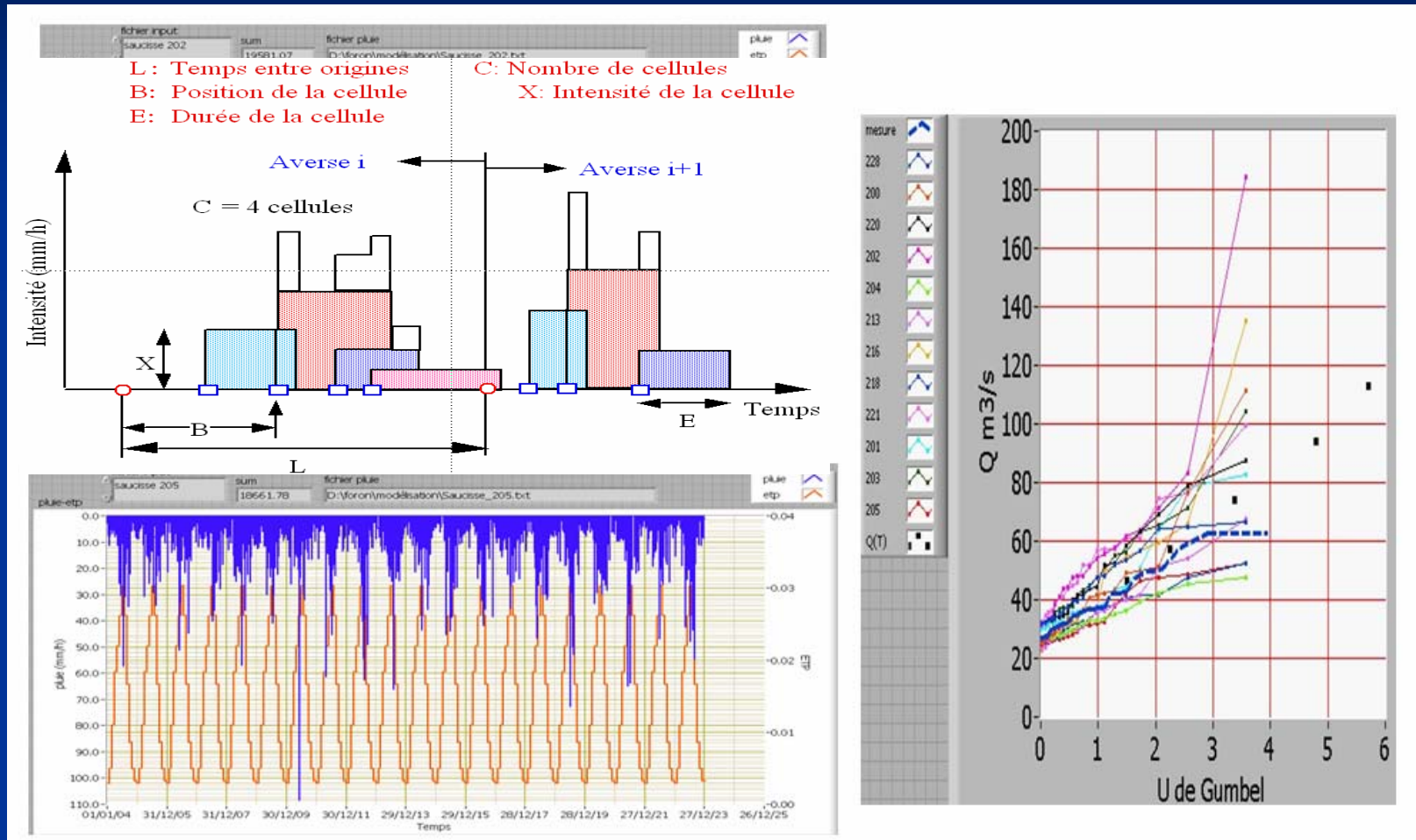


# Model URBAN and RURAL runoff Calibration against observed data





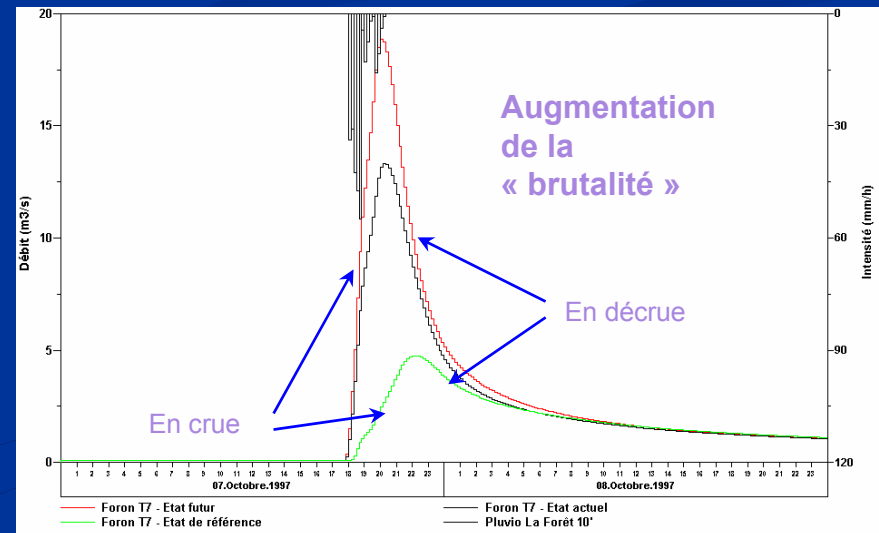
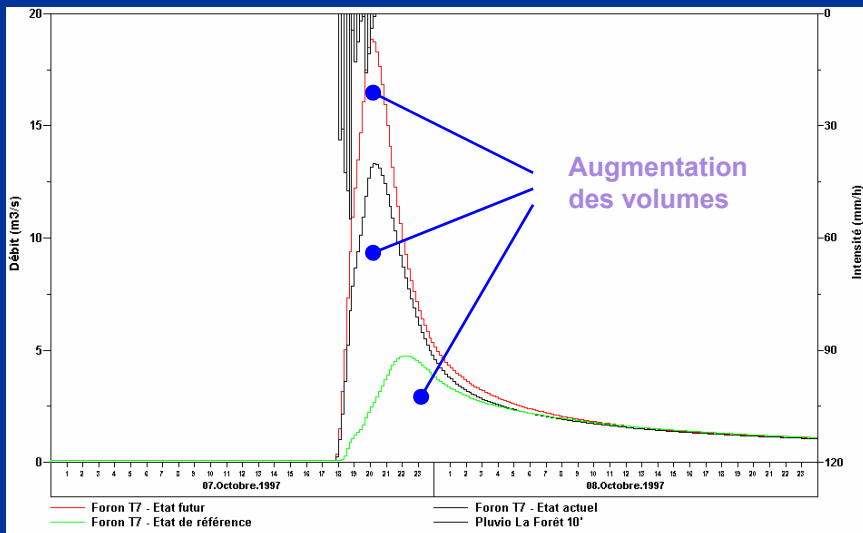
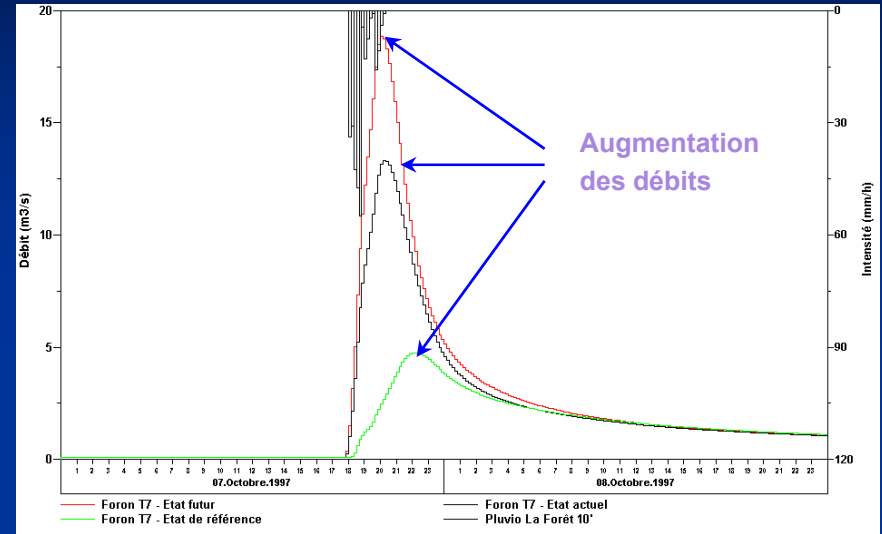
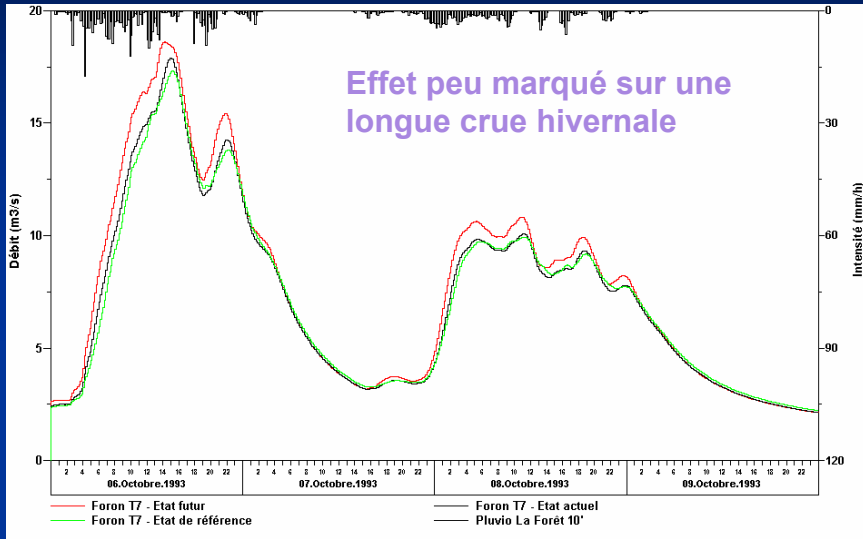
# Long term simulations at least 20 years



With observed and/or stochastic 10 min rainfalls

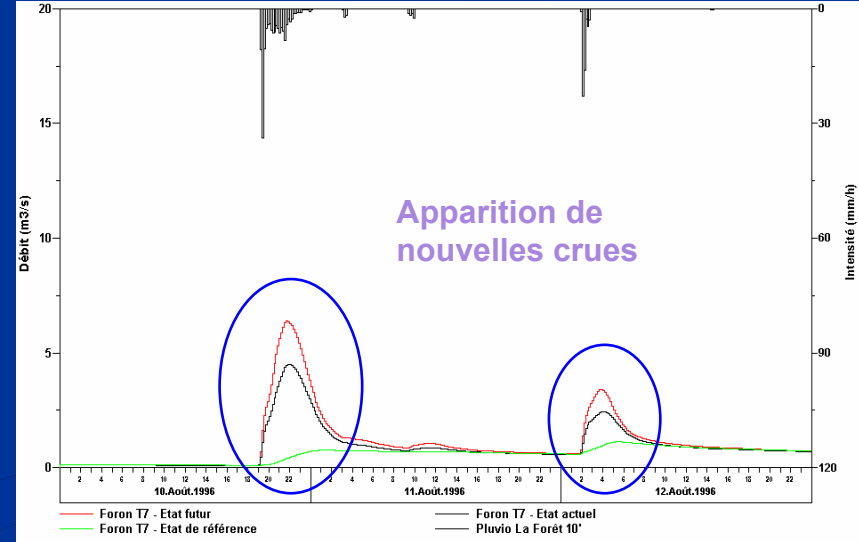
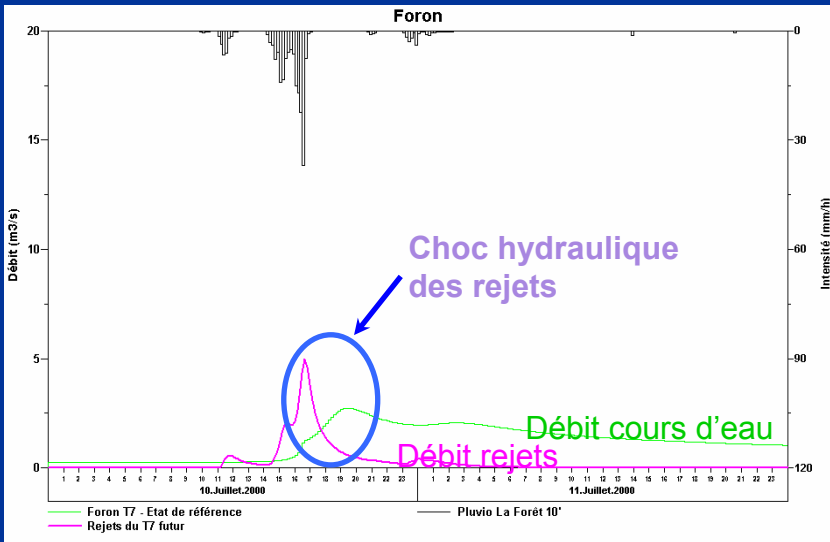
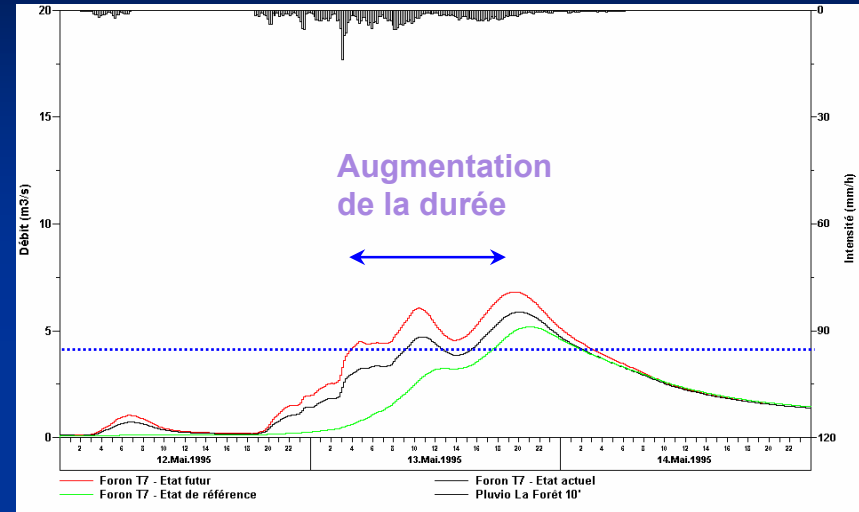
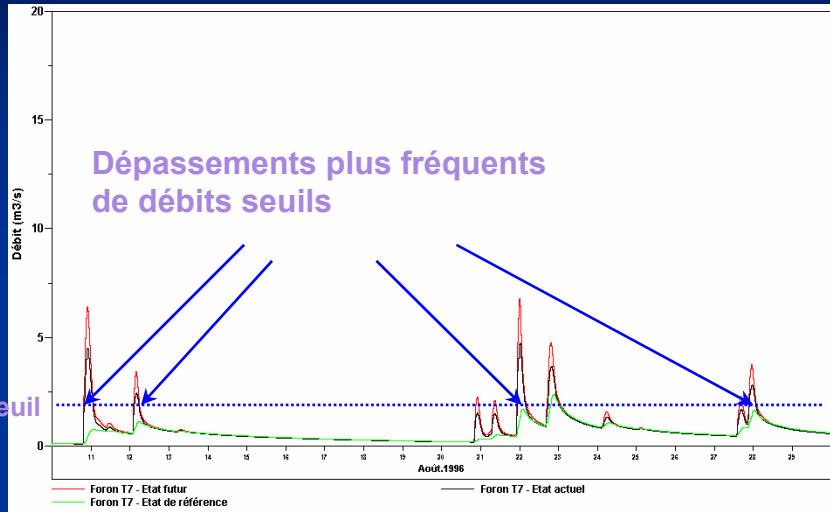


# Hydrological effects of urban runoff (1)





# Hydrological effects of urban runoff (2)



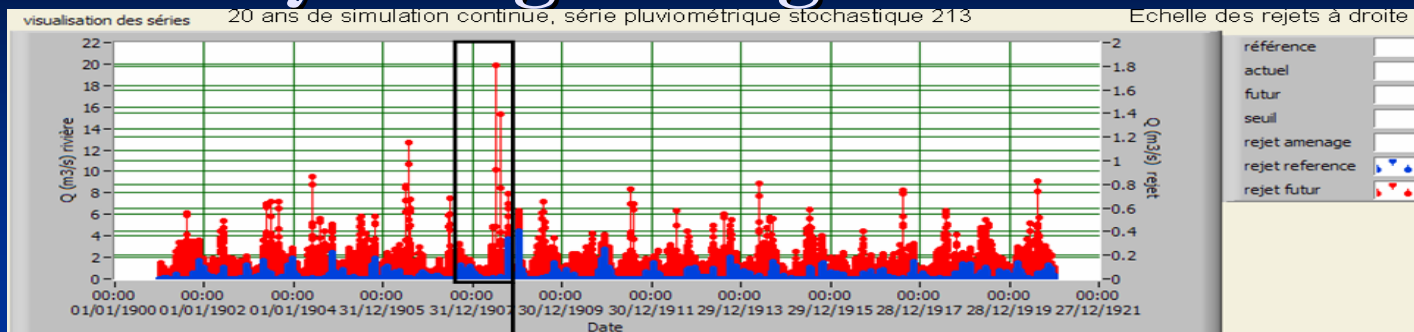


# Urban runoff increases

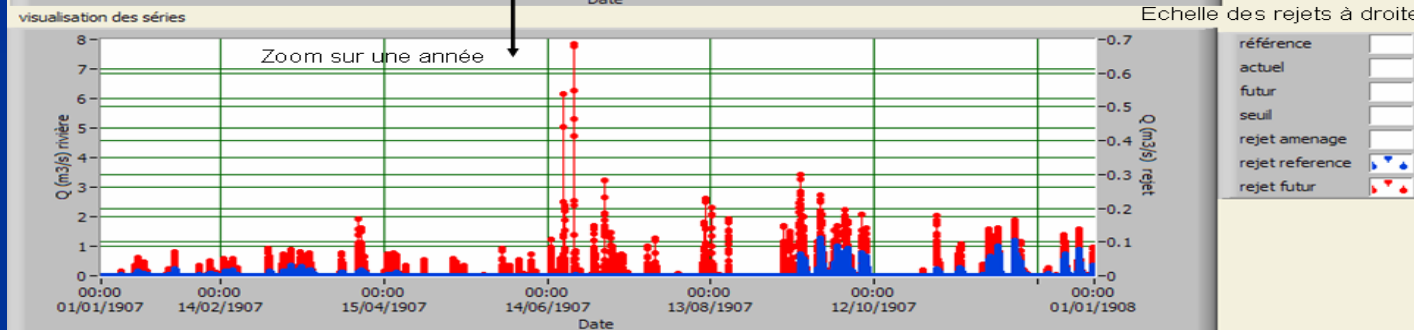
## Hydrological regimes are modified



20 ans

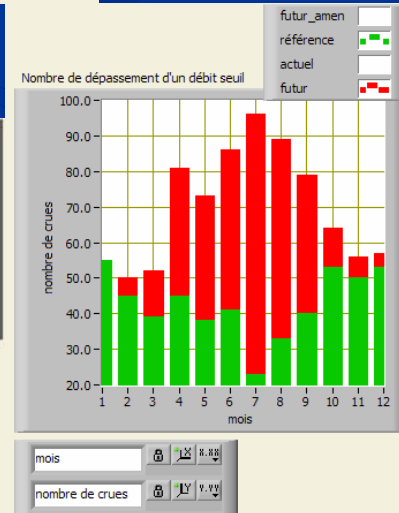
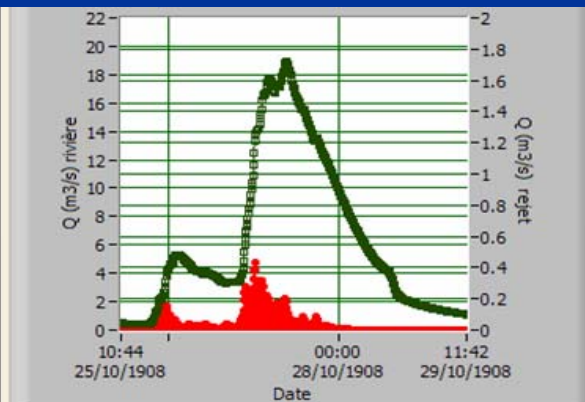
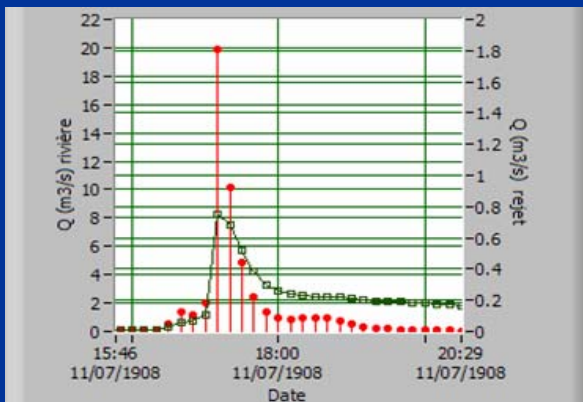


1 an



Crue estivale

Crue hivernale

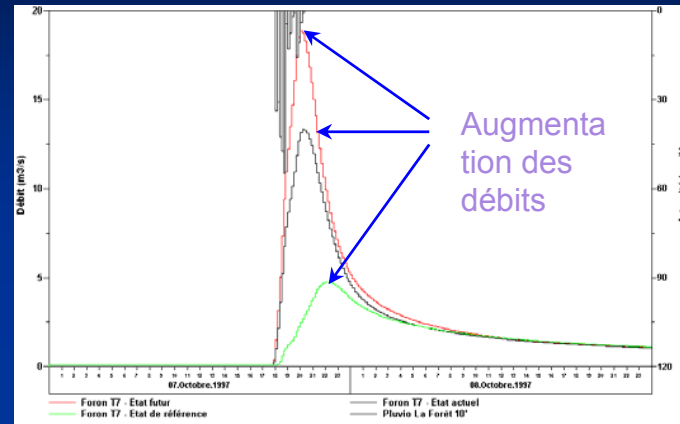
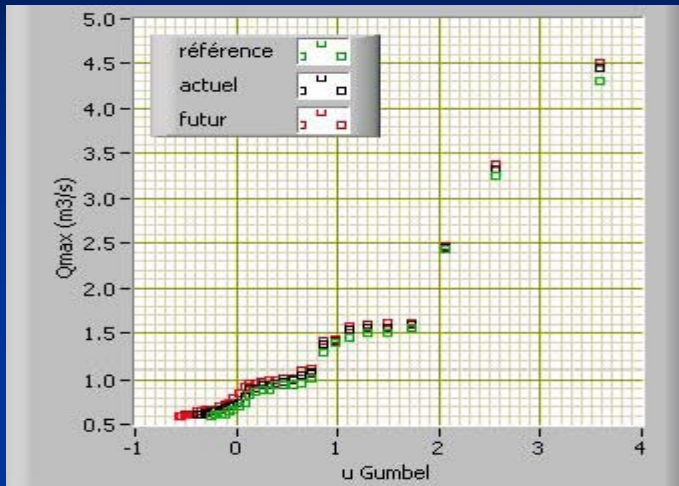




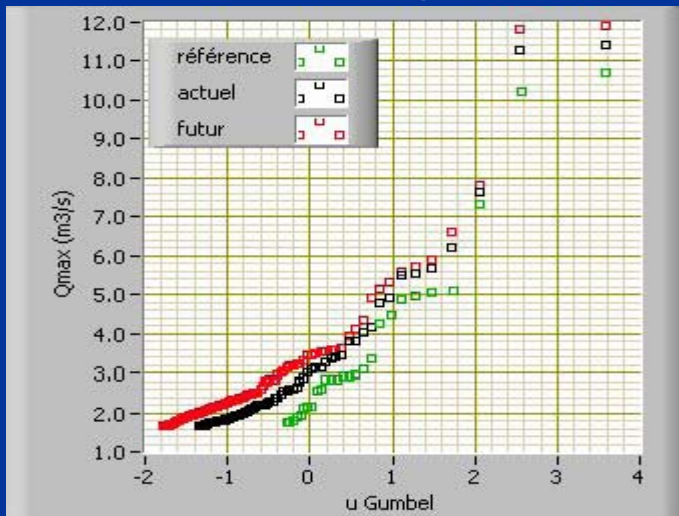
# Indicator : Flow statistics



Drize 03 (amont)



Drize T01 (aval Collonges)

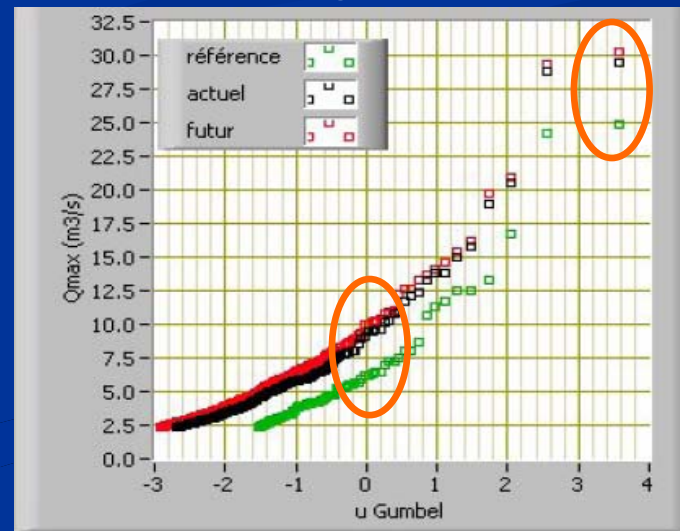


Futur

Actuel

Référence

Drize T12 (avant galerie)

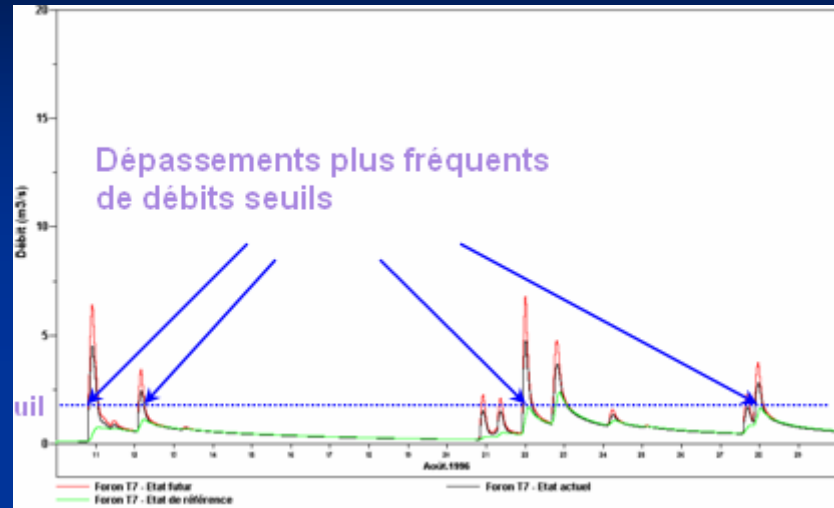
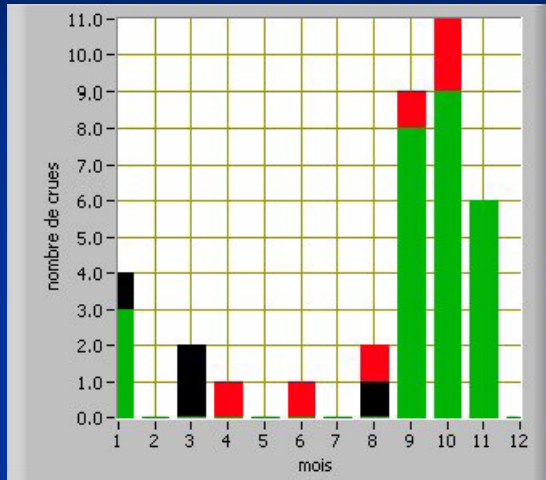


+ 20%

+ 90%

# Indicator : Peaks over threshold (POT)

Drize 03 (amont)  
Qseuil = 0.58 m3/s



Drize T01 (aval Collonges)  
Qseuil = 1.65 m3/s

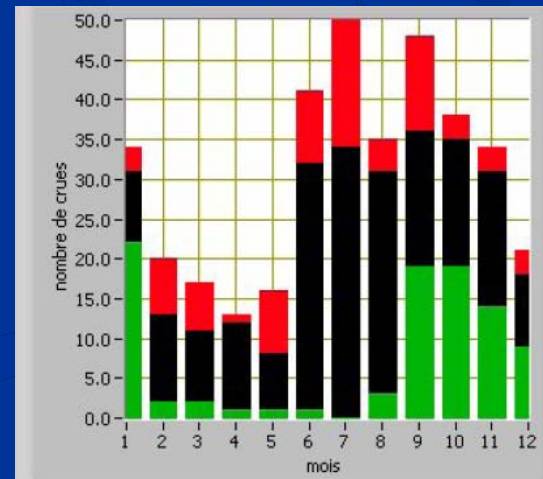


Futur

Actuel

Référence

Drize T12 (avant galerie)  
Qseuil = 2.4 m3/s



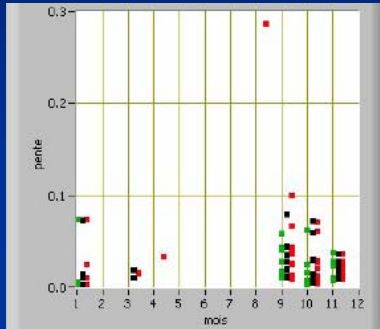


# Indicator : Flow peaking

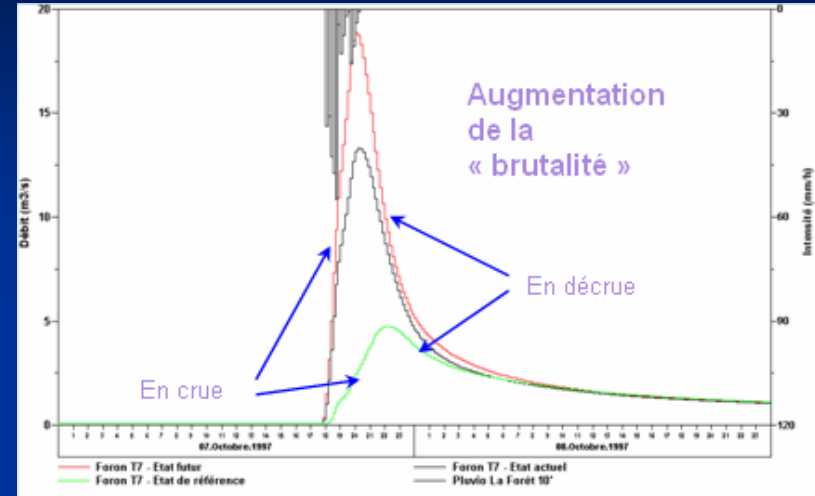
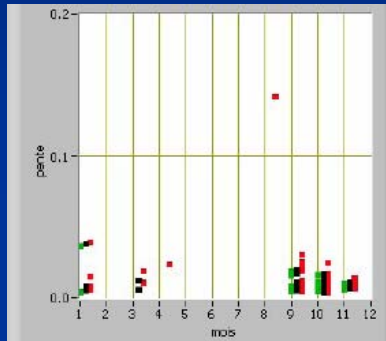


**Drize 03 (amont)**  
**Qseuil = 0.58 m3/s**

Montée



Descente



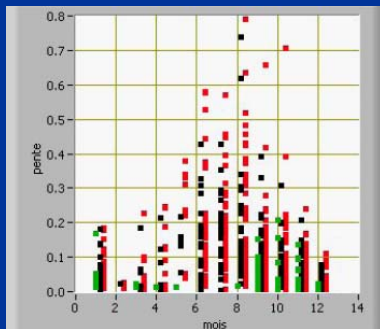
**Drize T01 (aval Collonges)**  
**Qseuil = 1.65 m3/s**

**Futur**

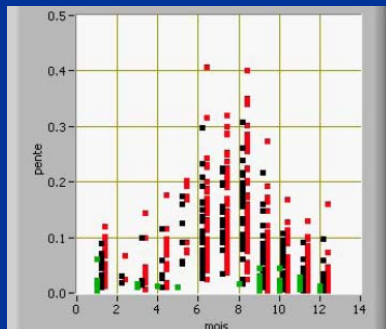
**Actuel**

**Référence**

Montée

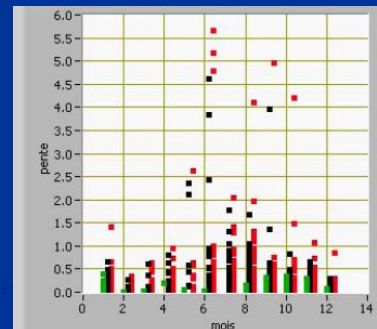


Descente

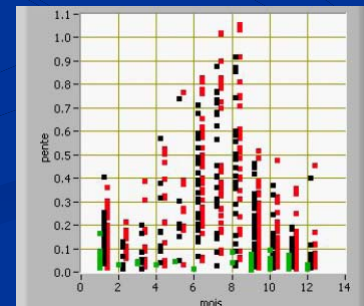


**Drize T12 (avant galerie)**  
**Qseuil = 2.4 m3/s**

Montée



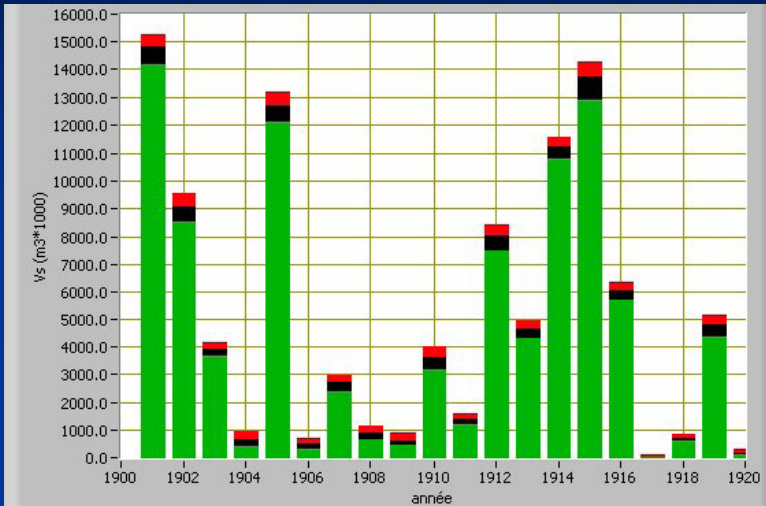
Descente



# Indicator : Bed load potential



Drize 03 (amont)



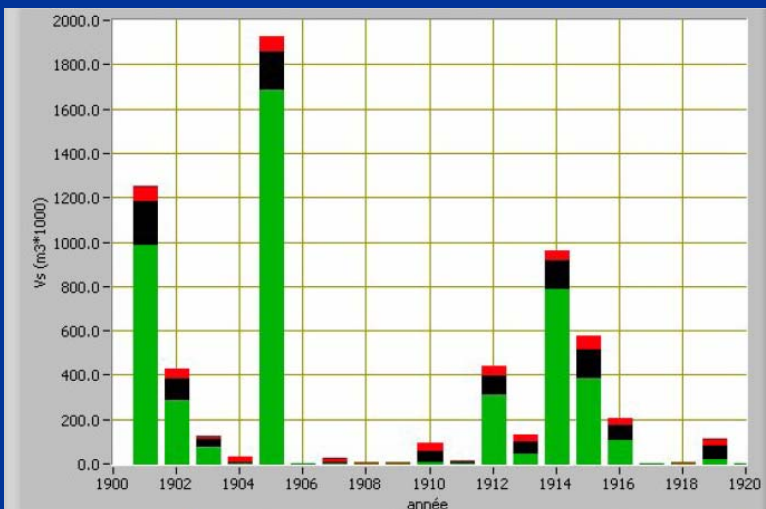
Futur

Actuel

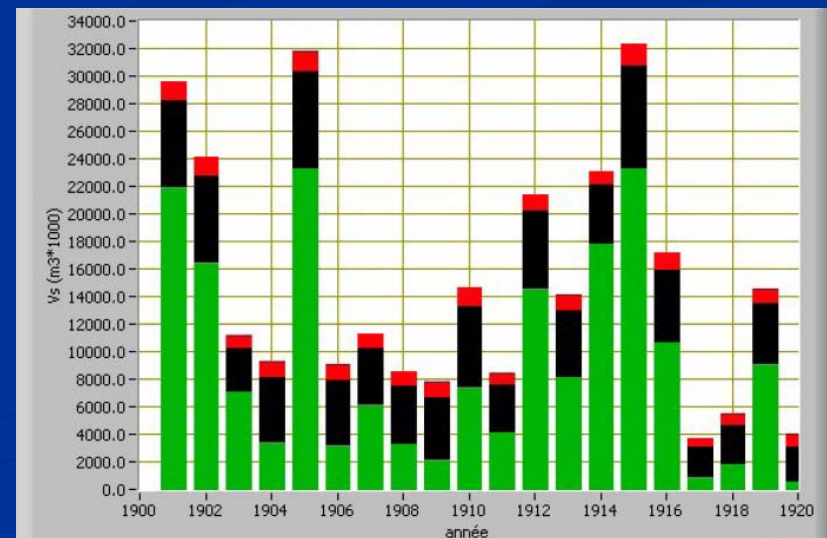
Référence



Drize T02 (aval Collonges)



Drize T12 (avant galerie)

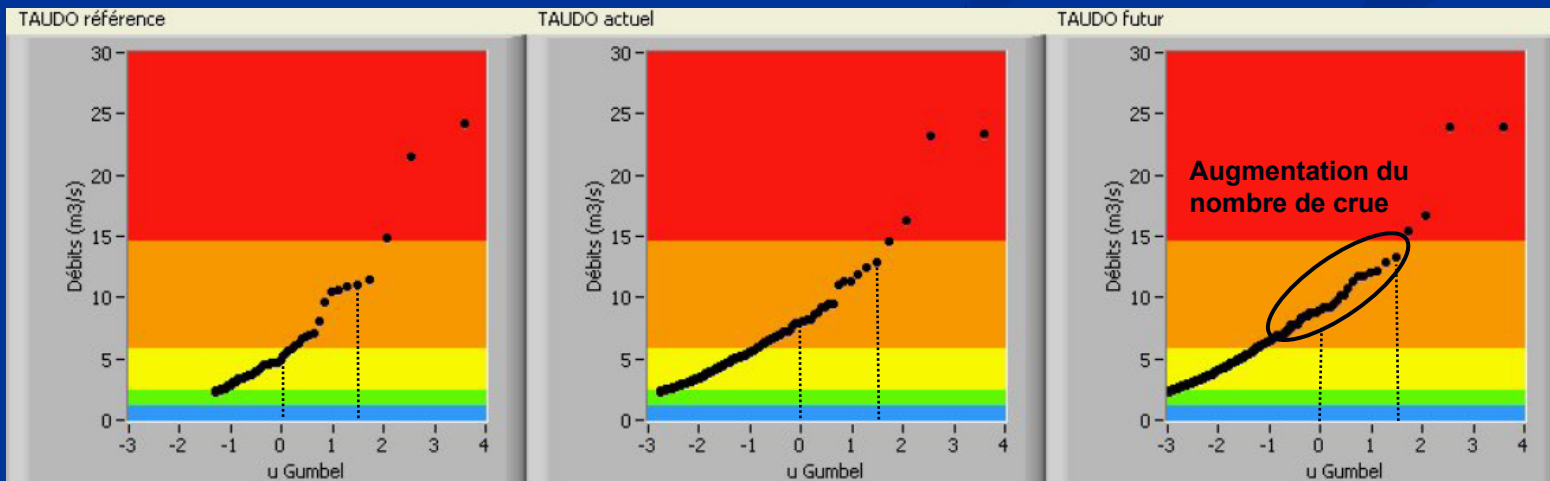
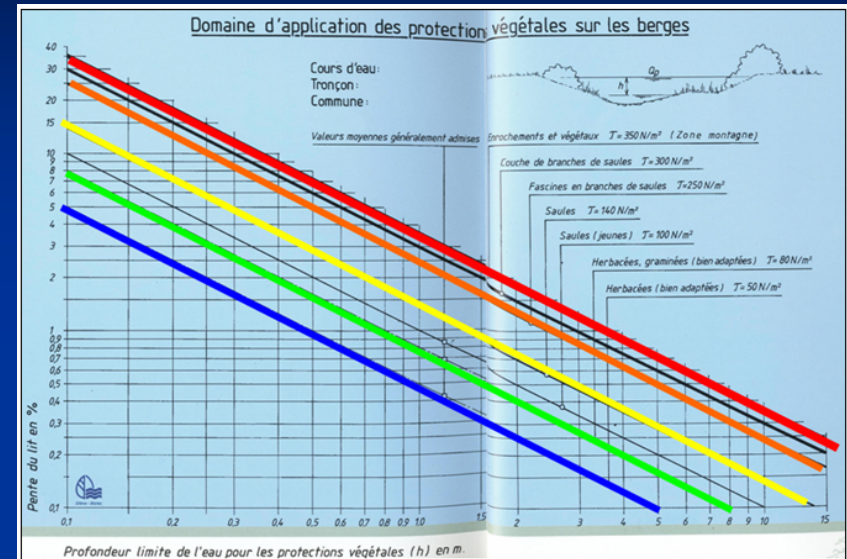




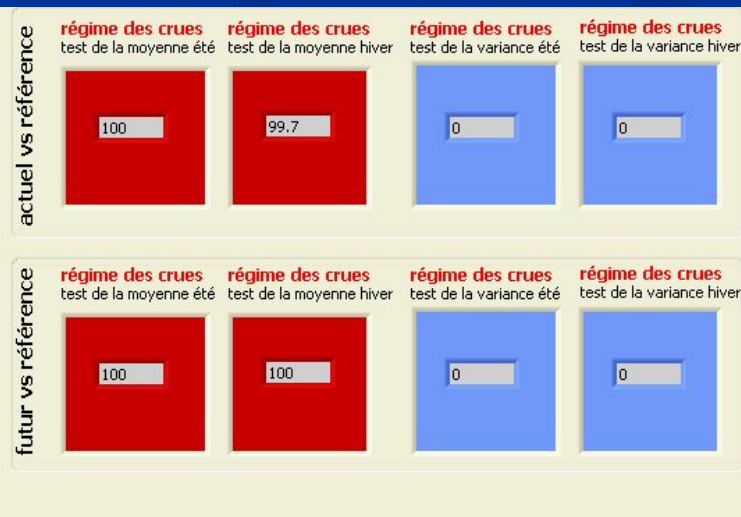
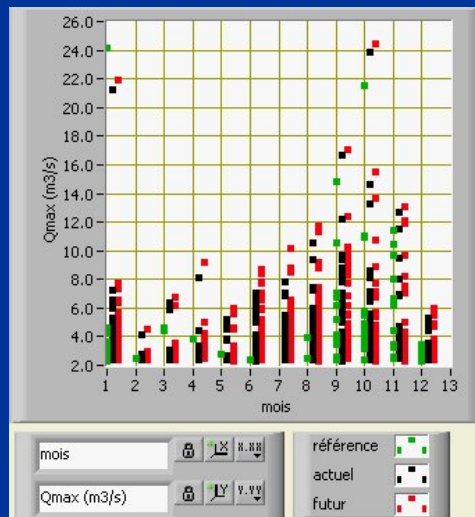
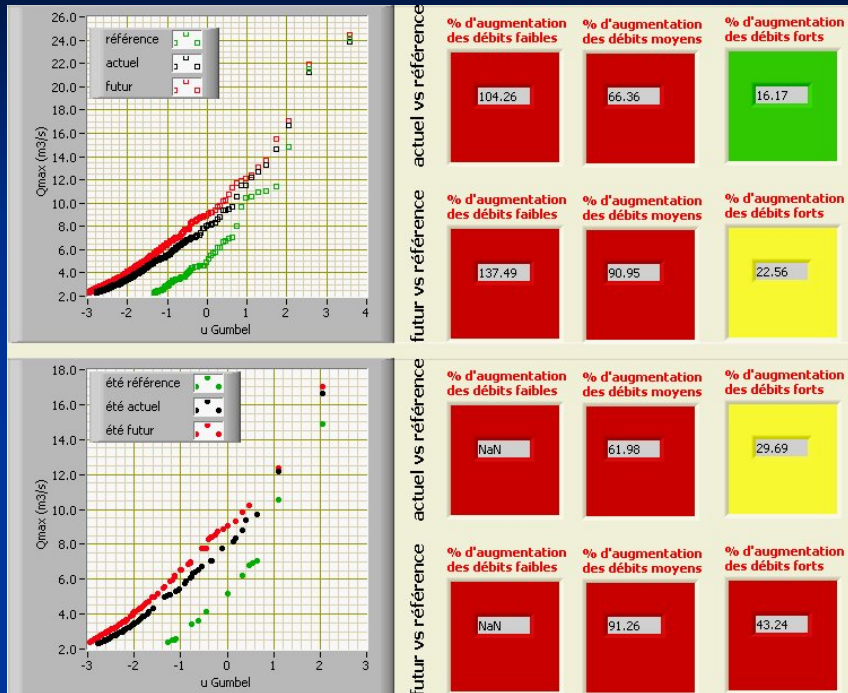
# Indicator : Bank shear stress



Contrainte érosive	Couleur	Limites	Type de revêtement des berges adéquat
Négligeable	bleu	$\tau < 50 \text{ N/m}^2$	Herbacées
Faible	vert	$50 \text{ N/m}^2 < \tau < 80 \text{ N/m}^2$	Herbacées, graminées
Moyenne	jaune	$80 \text{ N/m}^2 < \tau < 140 \text{ N/m}^2$	Saules
Forte	orange	$140 \text{ N/m}^2 < \tau < 250 \text{ N/m}^2$	Fascines en branches de saules
Très forte	rouge	$\tau > 250 \text{ N/m}^2$	Enrochement

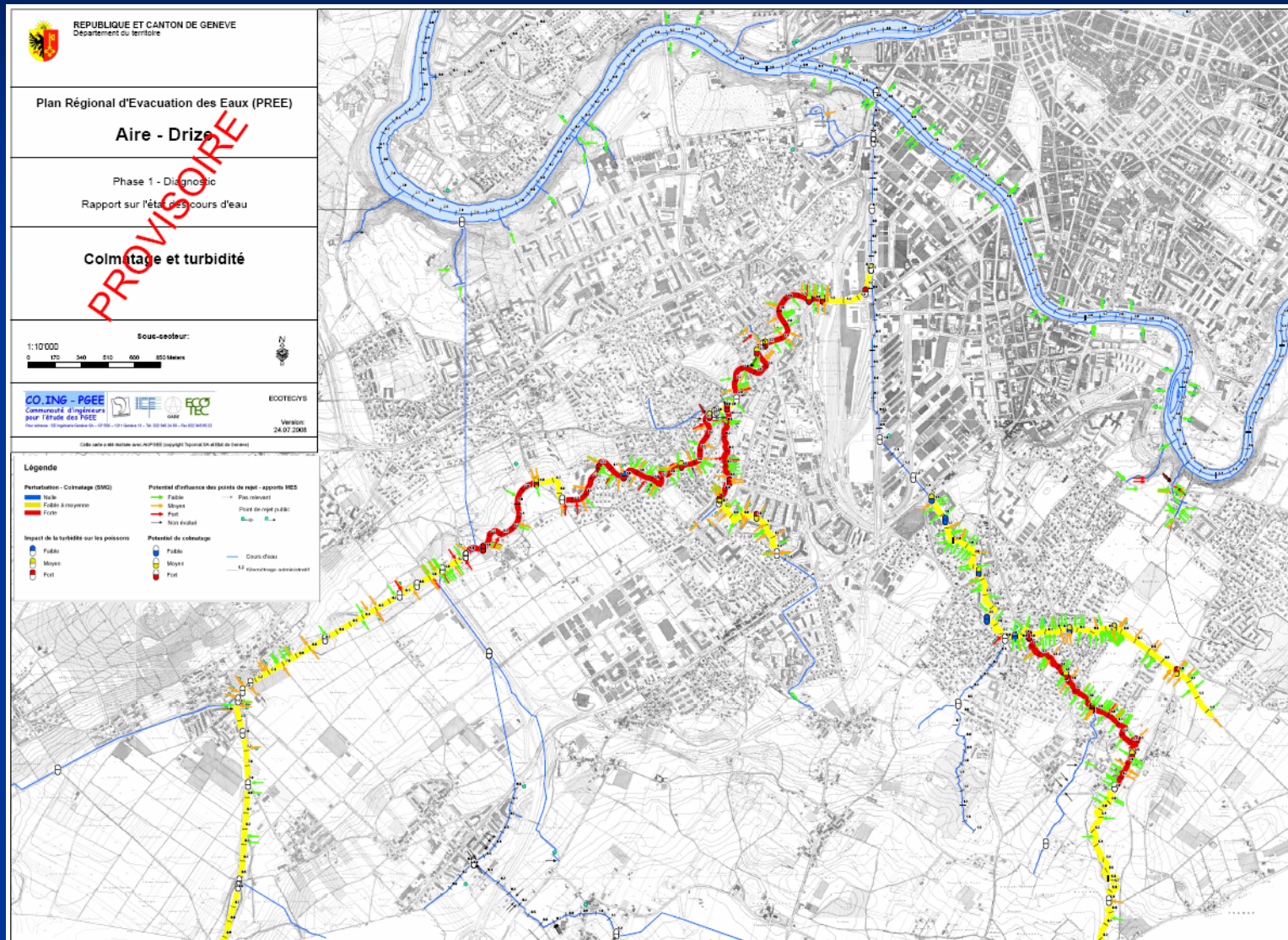


# Indicator : Simplified interpretation keys



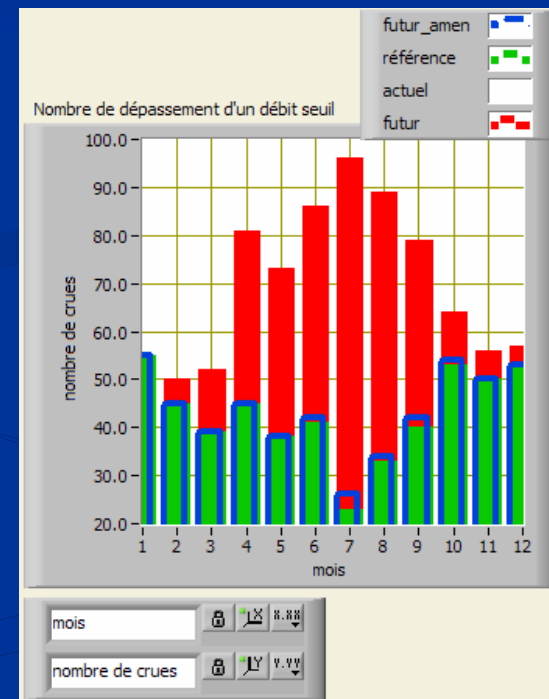
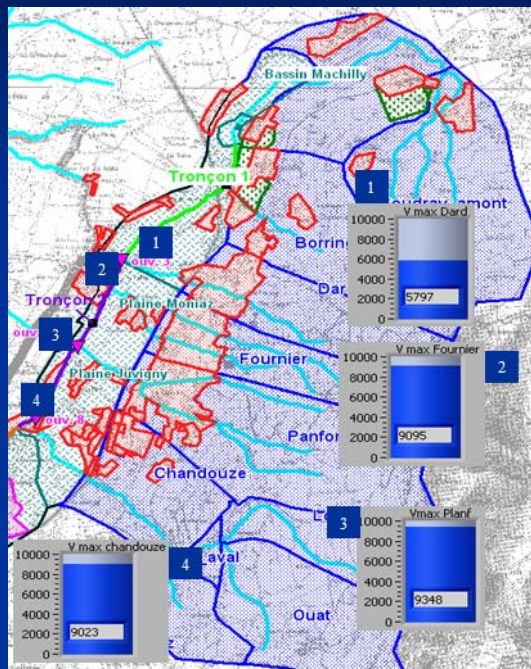
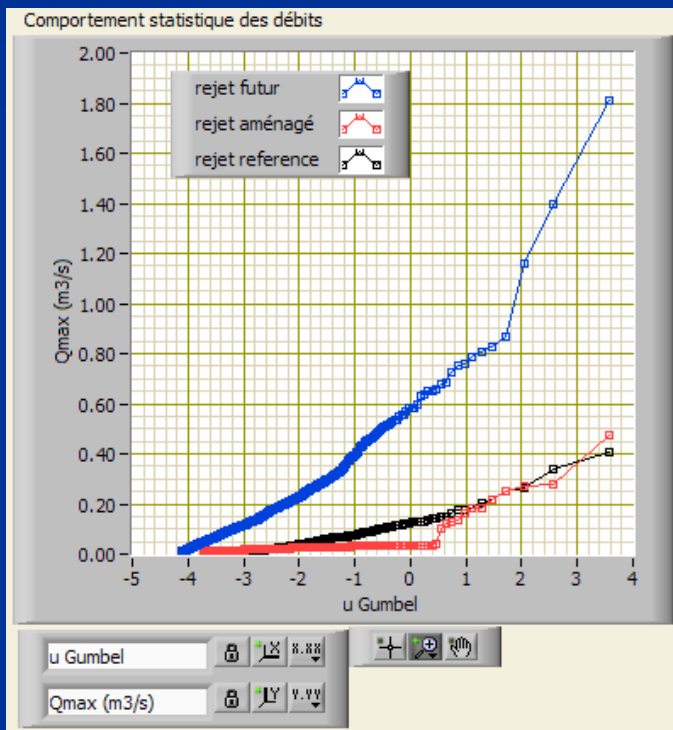


# Indicator : Diagnostic map production



# Indicators. How does it work?

## The case of the regime indicator



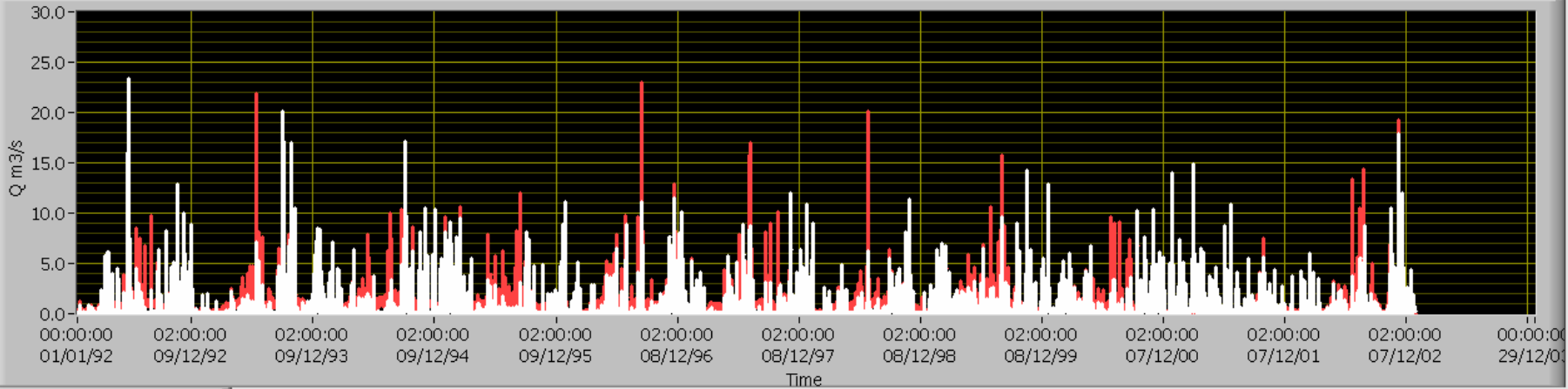
Performance de la gestion des débits au droit du rejet

Nombre de dépassements d'un débit seuil dans le tronçon de rivière concerné. Effet de la gestion des eaux



Simulé\_observé

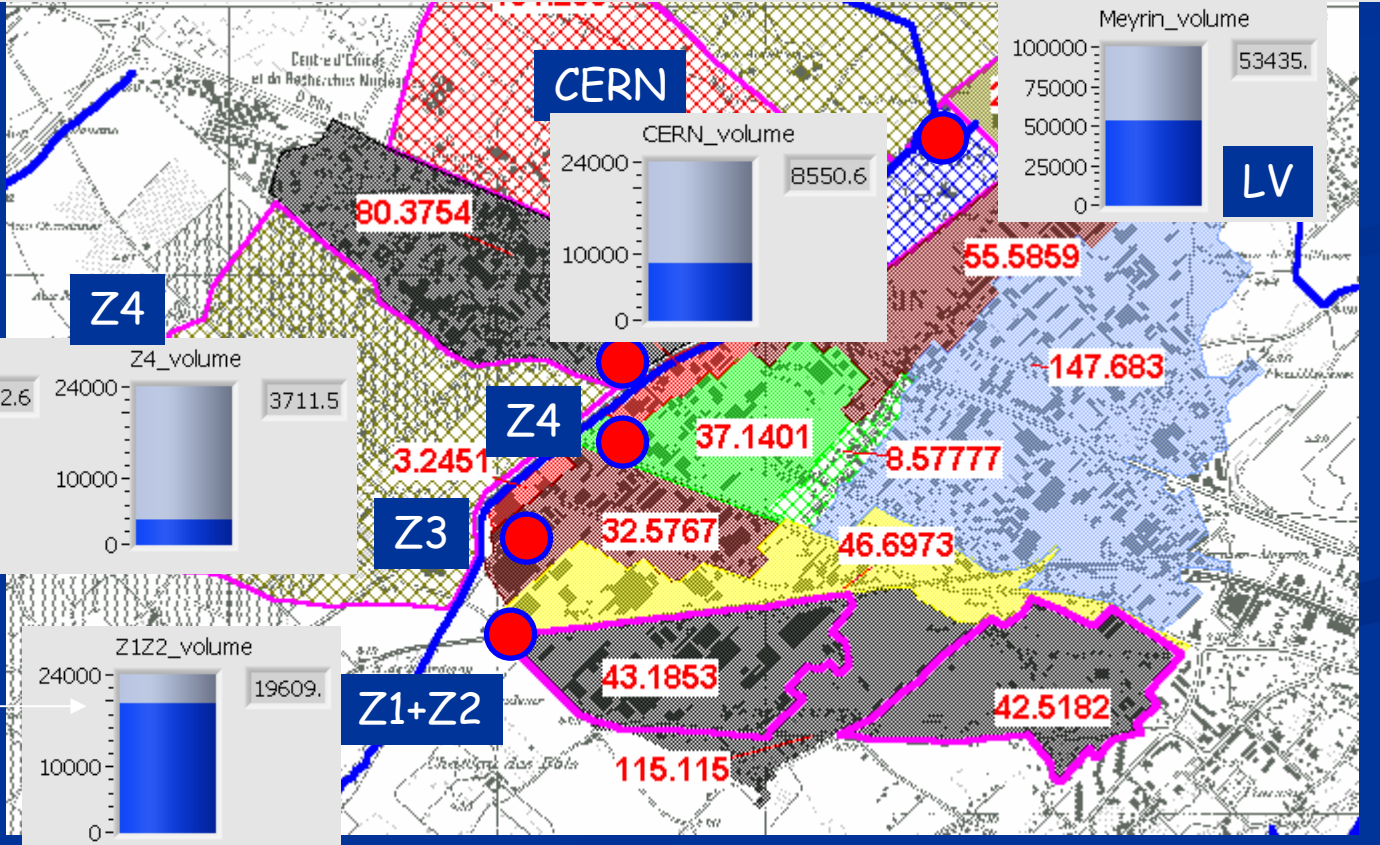
Sim  
obs



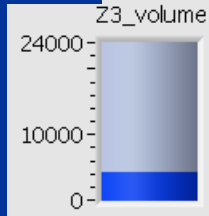
### Bilan sur 10 ans

● Rétention LV  
 Surface du BV ha

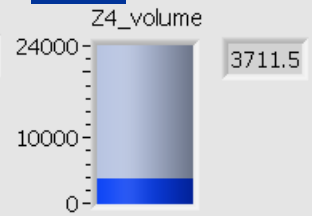
43.1853



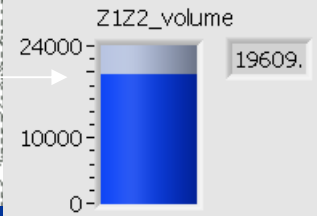
Z3



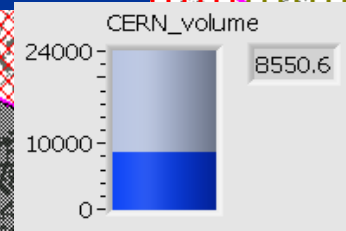
Z4



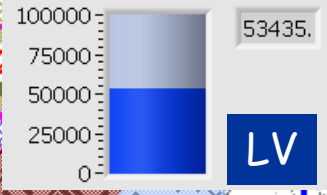
Volume de rétention



CERN



Meyrin\_volume



80.3754

55.5859

147.683

Z4

37.1401

8.57777

Z3

32.5767

46.6973

Z1+Z2

43.1853

42.5182

115.115

