Cartography of groundwater vulnerability to pollutants transfer in Western Part of La Réunion Island

Frédéric FEDER [a], Jean-Guillaume ROBIN [a], and Gérard BOURGEON [b]

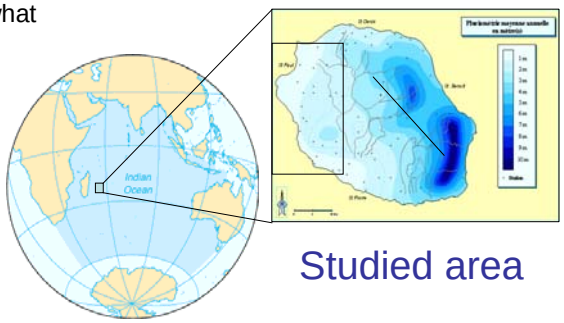
[a] CIRAD, UPR Risque environnemental lié au recyclage, La Réunion, Saint-Denis, F-97 408 FRANCE

[b] CIRAD, UPR Risque environnemental lié au recyclage, Montpellier, F-34 398 FRANCE

Introduction

Maps of groundwater vulnerability are used for the estimation of potential groundwater contamination at different scales. The western slope of Piton des Neiges (La Réunion island) presents a vadoze zone and aquifers somewhat homogeneous but a great variability of soil characteristics.

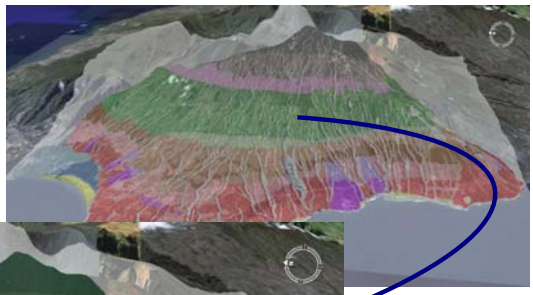
With DRASTIC-like approaches, soil properties are neglected to the benefit of hydro-geological properties. Nevertheless, transfer of many pollutants to the groundwater depends, principally, on soils properties: hydraulic conductivity, particule size fractions, bulk density, retention capacity, pH, sesquioxides content, organic matter content, etc. A specific objective of this work was to demarcate the most sensitive areas.



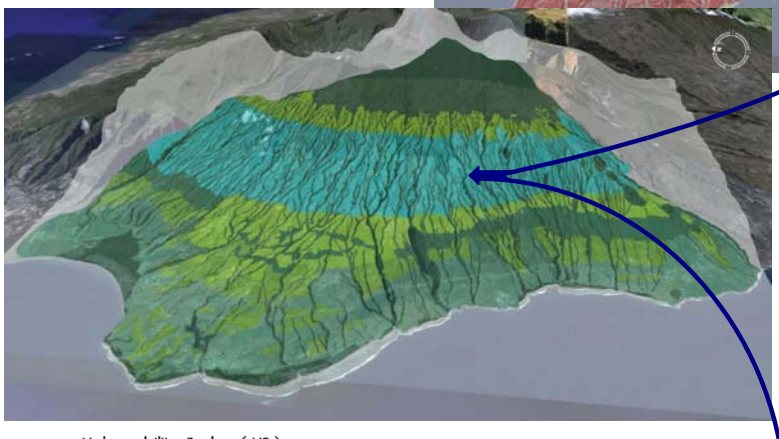
Studied area

Methods and Results

Soil map



Vulnerability map



Vulnerability Index (VI)
- 0 - 5 (minimal)
- 7 - 8
- 8 - 9
- 9 - 10 (medium)
- 10 - 11
- 11 - 12
- 12 - 15 (maximal)

For example, the soil unit “Andosol” was given a **Vulnerability Index** of 2 because of its low hydraulic conductivity (**f = 0**), high CEC (**f = 0**), and low pH (**d = 2**).

Hydraulic conductivity	>	CEC	>	pH	==>	Vulnerability Index
f = 0		f = 0		f = 0	f f f	0
f = 0		f = 0		d = 2	f f d	2
f = 0		d = 4		f = 0	f d f	4
f = 0		d = 4		d = 3	f d d	7
d = 6		f = 0		f = 0	d f f	6
d = 6		f = 0		d = 3	d f d	9
d = 6		d = 5		f = 0	d d f	11
d = 6		d = 5		d = 4	d d d	15

f = favorable and **d** = defavorable regarding groundwater protection.

Two different approaches have been tested to estimate the **Vulnerability Index (VI)** to pollutants transfer from the soil properties. Resulting maps were similars; vulnerability map defined with SIRIS model is presented here.

1 / The “index method”: each properties have been normalized and weightings factors (a, b…) have been deduced from literature and expert opinions.

VI = a HC + b CEC + c OM…

2/ The prioritization model based on a scoring system of penalties (SIRIS, Vaillant *et al.*, 1995, *Toxicology modeling*, 57-72.). This method avoids ambiguity for the comparison of complex situations.

For each unit of the soil map, soil properties were measured and were considered either as an advantage (**f**) or a disadvantage (**d**) regarding groundwater protection. Thus, a combination of **f** and **d** was obtained (see tab.) and the corresponding penalty score was attributed to draw the vulnerability map.

In the table, we postulate that hydraulic conductivity is more important (**>**) than CEC, and CEC than pH, etc. Thus, the scores of properties that disadvantage (**d**) groundwater protection were fixed higher for the most important soil properties than for the others.

Discussion and conclusions

These approaches suffer from some drawbacks (weighing factors, lack of validation, …) but they gave the opportunity to take into account the role of different soil properties.

Otherwise, this approach was mainly comparative for the studied area only.

Acknowledgements This work have received funding from FEOGA, DIREN and French Ministry of Overseas Territories.

CIRAD

Centre de coopération international en recherche agronomique pour le développement