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Abstract: The absence of strategies for sustainable use and management of hydric resources is probably the main reason of several negative environmental impacts. Among them we can point out the inadequate use of pesticides on crop fields located over vulnerable areas. Due to this, the assessment of water risk contamination potential in aquifers has extreme importance to drive practices in order to reduce undesirable contaminations. In the present work we use CMLS-94 simulator to evaluate the vertical movement of pesticides through soils in agricultural catchments over areas of aquifers in Brazil. 2-4D acid, dimethoate, prochloraz, methamidophos and carbendazim applied in yellow passion fruit were studied in loamy/clayey kaolinitic, isohyperthermic Typic Hapludult, sandy/loamy, kaolinitic, isohyperthermic Typic Hapludult, and loamy, oxidic, isohyperthermic Typic Kandiustox soils at the Igarapé Cumarú catchment, Pará State, where Pós-Barreira Aquifer is present. Additionally we studied the movement of hexazinone applied in sugarcane field crop in a Typic Eutrorthox soil in the Esparaiado catchment, where Guarani aquifer is present. The results of this study helped to prioritize local monitoring in terms of surface and groundwater pesticides contamination potential, as well as, that none of the studied pesticides presented any potential to contaminate the aquifers, when considered the evaluated scenarios.

Keywords: pesticides; aquifers; agriculture; hydric resources; Brazil.

1. INTRODUCTION

The short availability of freshwater in the world is a growing concern for water resources conservation. Moreover the poor water quality is an aggravating factor to the hydrological resource framework, contributing for increase the scarcity of this natural supply. Consequently the conservation and assessment of the effects caused by potential pollution sources on the water quality is a priority demand. As a matter of fact the development of **"*water management strategies at the regional, national and local levels, which promote both equitable access and adequate supplies*"** is emphasized by the United Nations Millennium Declaration [United Nations, 2000].

During the last decades the adopted agricultural production system has been highly dependent on the use of agrochemicals (pesticides, fertilizers and other inputs) to ensure productivity. In face of this, some wrong practices and technologies of pesticide application have been exposing the environment to potential contamination risks [Chaim et al., 1999]. Among them, it could be mention those that subject water resources to contamination risks of pesticide transports, both from its vertical movement into the soil and run-off, as well as the adoption of highly toxic or unsuitable products for certain crops. In order to prevent any adverse effect of pesticide application, it is recommendable to strength the Good Agricultural Practices (GAP) guidelines regarding to environmental education of farmers and the governmental laws that regulate the use of pesticide in specific agricultural crops, including minor crops. Regarding minor crops, it is important to emphasize that since 2002 the Brazilian Ministry of Agriculture, Livestock and Supply (MAPA) has been studying the guidelines and requirements for registering pesticides for particular crops, due to their social-economical importance to Brazilian small farming. For this reason, several research activities have being carried out to support these regulatory instructions. Besides that, it has been also important to evaluate trends of potential impacts caused by the pesticides use in intensive crops.

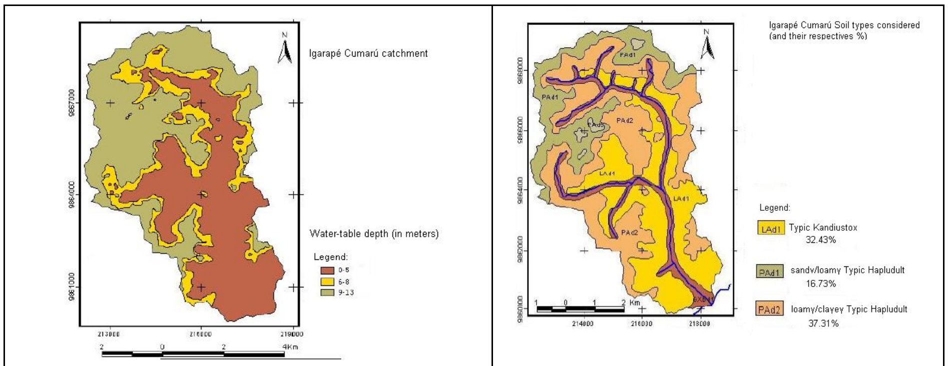
Presently the use of simulation systems, which consider input data *in situ*, is useful to trace the spatial-temporal dynamics of pesticides along their vertical movement through the soil profile. By delineating several different scenarios, it is possible to identify trends and concentrations of depths reached by pesticides in different places over a previous determined period of time. These scenarios can be used as support for more efficient decision-making regarding to the monitoring, which involves higher costs in their implementation, as well as, to identify the most relevant periods to that information collection on the spot. Several simulation tools are available for simulating the movement of pesticides in the soil profile. Among them, Embrapa Environment has evaluating the Chemical Movement in Layered Soils CMLS94 [Nofziger & Hornsby, 1994] for some pesticides in Brazil, as well as, made pesticide residues analysis of local water [Queiroz et al., 2007; Ferracini et al., 2007; Cerdeira et al., 2007, 2005, 2004; Gomes et al., 2006; Lanchote et al., 2000]. These researches have been allowed the improvement of CMLS94 trends applications, also regarding to compare their results with those provided by methods and equipments of laboratorial residues analysis. The present work presents results reached using CMLS-94 simulator to evaluate trends of water potential contamination by vertical movement of pesticides through soils in agricultural catchments over areas of aquifers in Brazil. 2-4D acid, dimethoate, prochloraz, methamidophos and carbendazim applied in yellow passion fruit were studied in **loamy/clayey kaolinitic, isohyperthermic Typic Hapludult**, **sandy/loamy, kaolinitic, isohyperthermic Typic Hapludult**, and **loamy, oxidic, isohyperthermic Typic Kandiustox** soils at the Igarapé Cumaru catchment, Pará State, where Pós-Barreira Aquifer is presented. Additionally it was presented a study of the movement of hexazinone applied in sugarcane field crop in a **Typic Eutrorthox** soil of the Esparaiado catchment, where Guarani aquifer is present.

2. MATERIAL AND METHODS

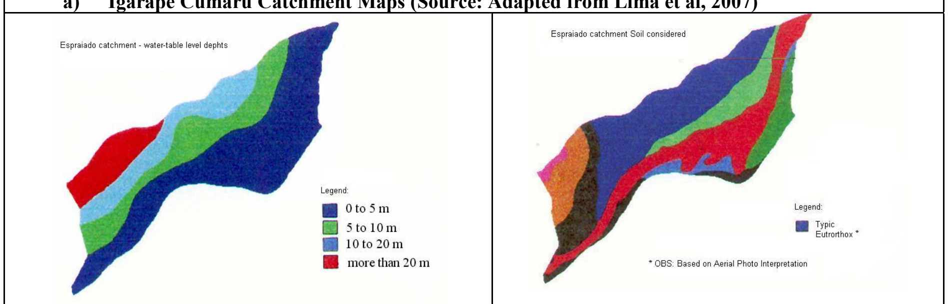
2.1. Studied areas

The fist study area is the **Igarapé Cumaru** catchment, which is located in Igarapé Açú municipality, between latitudes 01°10'40'' and 01°16'06'' SGr and longitudes 47°31'34'' and 47°35'15'' WGr , in an altitude of 65 m, Pará State, Brazil. Four research projects provided information and data for this evaluation ("Agrobacias Amazônicas" (EMBRAPA/SEG), MCT/CNPq/CT-HYDRO-502626/03-8, MCT/CNPq/CT-HYDRO-505585/04-9, and MCT/CNPq/Millennium Institutes - 420199/05-5). The climate is humid tropical (Am) with an average temperature of 26°C and a dry season with less than 60 mm of rainfall during the driest month, in accordance with Koppen classification [Mickel, 2004]. The average annual rainfall is about 2,500 mm ±10%, where 60% falls during the wet season with highest frequency between March and April and the lowest between September and October [Lima et al, 2007; Mickel, 2004]. This catchment comprehends 4,121.50 hectares. The dominant vegetation of this region is a mosaic mostly of secondary forests, pastures and small agricultural fields of corn, beans, manioc, passion fruit, and white pepper [Wickel et al., 2008]. Soil and water-table characteristics are presented in **Figure 1a**.

The second study area is the **Espraiado catchment**, which has 4,141 hectares and it is located at the North region of the São Paulo State, landmark of Ribeirão Preto, Cravinhos and Serrana municipalities [Gomes, 2006; IPT, 1994]. Embrapa Environment projects provided information on data for this study (SIGER/SEG/11.94.221, 11.2002.236, and 02.08.060020003). In accordance with Koppen classification, the climate of the region is tropical rainy with dry winter and cooler months with average temperature above 18 °C (Aw) and average pluviosity of 1422.5 mm.year^{-1}. The potential evapotranspiration reaches 1000 mm.year^{-1}, in accordance with Thorntwaite method. The sugarcane crop is prevalent in the studied area, although it is also found a little quantity of corn, bean, peanuts, pasture, eucalyptus and pines [Gomes, 2006]. Soil and water-table characteristics are presented in **Figure 1b**.



a) Igarapé Cumarú Catchment Maps (Source: Adapted from Lima et al, 2007)



b) Espraiado Catchment Maps (Source: Adapted from Pessoa et al., 1999)

Figure 1: Water-table and soil types considered on both studied areas.

2.2. CMLS94 simulation

Chemical Movement in Layered Soils- CMLS94 [Nofziger & Hornsby, 1994] was used in order to evaluate the vertical movement of the pesticides into the main soil types of both studied catchments. The simulator inputs were: a) daily maximum and minimum temperatures (°C); b) daily rainfall (mm); c) daily evapotranspiration; d) organic-carbon coefficient (Koc) and soil half-life (t½) of pesticides on each soil type studied; d) percentage of organic carbon, bulk density, field capacity, wilting point and saturation for each soil type; e) crop cultural coefficients (Kc) for each crop evaluated; f) pesticide initial doses (kg.ha^{-1}), and time (months) and depth (m) of their applications. CMLS94 does not enable to consider reapplications of the pesticides.

The scenarios proposed for the Igarapé Cumarú catchment considered the following factors: a) simulation period: from January 1st, 2003 to December, 31st, 2005; b) soil types: **loamy/clayey kaolinitic, isohyperthermic Typic Hapludult** (**soil 1**); **sandy/loamy, kaolinitic, isohyperthermic Typic Hapludult** (**soil 2**) and **loamy, oxidic, isohyperthermic Typic Kandiustox** (**soil 3**), which characteristics were provided by the Soil Laboratory of Embrapa Eastern Amazon (**Table 1**); c) weather: daily maximum and minimum temperatures, and rainfall information provided by the Climatology Laboratory of Embrapa Eastern Amazon; d) crop: yellow-passion fruit, with planting date on January 1st, 2003, as well as crop coefficient (Kc) presented by Corrêa [2004] and Silva [2005] and root depth of 0.15m [Corrêa, 2004]; e) evapotranspiration: considered each soil evaluated and were daily calculated for the simulated period using Penman-Monteith and Priestley-Taylor Methods[Pereira, 1997; Priestley & Taylor, 1972; Smith, 1991]; f) pesticides: 2-4D acid or (2,4-dichlorophenoxy) acetic acid (CAS 94-75-7; herbicide; chlorophenoxy acid or ester), dimethoate (CAS 60-51-5; insecticide; organophosphorus), prochloraz (CAS 67747-09-5; fungicide; azole), methamidophos (CAS 10265-92-6;insecticide; organophosphorus), and carbendazim (CAS10605-21-7; fungicide; benzimidazole), which doses and characteristics (Koc and t½ soil) were presented (**Table 2**), totalizing 21 scenarios simulated. Thus, for pesticides that have more than one data set about their characteristics, it was considered their variation ranges for the final trend analysis presented.

Table1. Igarapé Cumaru catchment soil type characteristics

Depths (m)	OC (g kg$^{-1)}$	ds (Mg .m^{-3})	FC (dm^{3}dm^{-3})	PWP (dm^{3}dm^{-3})	S (dm^{3}dm^{-3})
Soil 1: loamy/clayey kaolinitic, isohyperthermic Typic Hapludult					
0.20	9.0	1.50	0.20	0.03	0.52
0.40	4.3	1.49	0.27	0.06	0.50
0.60	3.2	1.49	0.29	0.07	0.53
0.80	2.7	1.48	0.27	0.07	0.57
1.00	2.3	1.48	0.27	0.07	0.56
1.20	1.7	1.47	0.23	0.07	0.60
1.40	1.5	1.46	0.24	0.07	0.55
Soil 2: sandy/loamy. kaolinitic. isohyperthermic Typic Hapludult					
0.20	6.5	1.46	0.16	0.02	0.52
0.40	4.4	1.46	0.21	0.04	0.46
0.60	3.8	1.46	0.23	0.06	0.48
0.80	2.8	1.46	0.22	0.06	0.49
1.00	2.4	1.45	0.21	0.06	0.60
1.20	2.3	1.45	0.21	0.06	0.58
1.40	2.3	1.45	0.22	0.06	0.56
Soil 3: loamy. oxidic. isohyperthermic Typic Kandiustox					
0.20	6.8	1.47	0.16	0.03	0.72
0.40	4.5	1.45	0.16	0.05	0.57
0.60	3.5	1.40	0.14	0.05	0.58
0.80	2.4	1.38	0.14	0.05	0.55
1.00	2.6	1.37	0.12	0.05	0.54
1.20	2.5	1.36	0.13	0.04	0.49
1.40	1.9	1.35	0.14	0.04	0.53

Obs. OC = Organic carbon; ds= bulk density ; FC= field capacity (humidity); and PWP=wilting point (humidity); and S= saturation (humidity).

When considering the Espraiado catchment simulation, the followed input data were provided: a) simulation period: 18 months; b) soil type: **Typic Eutrorthox** soil type, were provided by Soil Laboratory of Embrapa Environmental; c) weather: daily maximum and minimum temperatures, and rainfall information provided by Climatology Section of the Agronomic Institute of Campinas (APTA/IAC-SP); d) crop: sugarcane with crop coefficient (Kc) presented by Paranhos[1987] (option PLANALSUCAR), cane-cut date at August, 20th, and root depth of 0.60 m; e) evapotranspiration: considered the soil evaluated, which daily evapotranspiration was calculated for the simulated period using Penman-Monteith and Priestley-Taylor Methods; f) pesticide: hexazinone (CAS number: 51235-04-

2; herbicide; triazinone), which application was considered at the soil surface on September, 20th with a initial dose of 0.40 $kg.ha^{-1}$; g) scenarios: two different scenarios were simulated in order to compare the influence of input data in the results provided by CMLS94. Thus, the first scenario (**scn1lab**) considered Koc= 26.3 $mL.g^{-1}$ and t½= 134.5 days, which both were determined at the Residue and Contaminant Laboratory of Embrapa Environment, considering the studied soil type (Queiroz et al..2007, 2006). The second scenario (**scn2def**) considered the CMLS94 pesticide database, which take into account literature default values, for hexazinone herbicide: t½= 90 days, and Koc = 54 $mL.g^{-1}$. At the simulation ending, depths (m) reached in each scenario were compared with the water table depth levels, which varies from 0 to 20m in the area, as well as with the saturated zone level (40m) [IPT, 1994].

Table 2. Doses and characteristics of evaluated pesticides

Active principle	Dose ($kg.ha^{-1}$) [a]	K_{oc} ($mL.g^{-1}$)	t½ soil (days)
2-4D	1.34	20[b], 20[c,e]	7[b], 10[c,e]
Dimethoate	0.60	11[d],20[c,e]	5 [d], 7[c,e]
Carbendazim	0.38	400[c]	120[c]
Prochloraz	0.60	500[c]	120[c]
Methamidophos	0.60	5[c,e]	6 [c,e]

Obs: Information sources: a-Cruz [2006]; b- Extoxnet/PIP [2006]; c- OSU[2006]; d- PAN [2006]; e- Ware [1992];

Table 3. Espraiado catchment Typic Euthorthox soil type characteristics.

Dephts (m)	OC ($g\ kg^{-1}$)	ds ($Mg\ m^{-3}$)	FC (dm^3dm^{-3})	PWP (dm^3dm^{-3})	S (dm^3dm^{-3})
0.20	9.4	1.28	0.268	0.155	0.52
0.40	8.5	1.44	0.204	0.167	0.46
0.60	6.5	1.25	0.198	0.173	0.53
0.80	6.0	1.13	0.197	0.175	0.57
0.10	5.0	1.12	0.210	0.169	0.58
0.12	4.5	1.04	0.187	0.172	0.61

Obs. OC = Organic carbon ; ds= bulk density ; FC= field capacity; PWP= wilting point; and S= saturation.

3. RESULTS

The scenarios evaluated for the Igarapé Cumarú indicated different responses to each pesticide: **a) 2,4-D acid** – The pesticide showed a similar initial behavior in all soil evaluated, remaining at depths close to the soil surface (depths near to 0.003 m and amounts between 2.0 X 10^{-1} and 3.5 X 10^{-1} $kg.ha^{-1}$) until 30 days after application, when started the vertical movement and reached the culture root zone in all soils simulated (in amounts ranging from 7.4 X 10^{-2} $kg.ha^{-1}$ to 1.7 X 10^{-1} $kg.ha^{-1}$). Since then, it was observed a greater movement in the **Soil 1** (**loamy/clayey kaolinitic, isohyperthermic Typic Hapludult),** where reached 0.22 m, when compared with **Soil 2 (sandy/loamy, kaolinitic, isohyperthermic Typic Hapludult)** and **Soil 3 (loamy, oxidic, isohyperthermic Typic Kandiustox),** where reached 0.16 m and 0.17m, respectively. After 31 days of application, the product remaining around the soil surface, 0.35 m depth, in amounts ranging from 6.0 X10^{-2} $kg.ha^{-1}$ to 1.5 X 10^{-1} $kg.ha^{-1}$, in **Soil 2**, while close to 0.26m in a same amount variation range on the other soils evaluated. At 48 days of application, 2,4-D acid presented potential to be found at 2.2 m in both **Soil 1** and **2**, in quantities ranging from 4.7 X 10^{-2} kg ha^{-1} and 1.1 X 10^{-2} kg. ha^{-1}, while in **Soil 3** initiated a higher descent process, lying to 3.0m in the same range of amount of the other soils. From 72 days the product was observed at 5.5 m in the **Soil 3** and close to 4.0 m in the others, but in quantities in the order of 10^{-4} kg ha^{-1} for all studied soils. Leaching continued presenting the same pattern until 95 days after application, when the 2,4-D acid presented potential to be found around 7.5 m in the **Soil 3** and 5.5 m in **Soils 1** and **2**, even showing quantities in the order of 10^{-3} kg ha^{-1}. Thereafter, no further monitoring is warranted, according to the tendency of the likely remaining quantities verified; **b) Carbendazim** – The pesticide presented potential to remain on the soil surface until 19 days after application date in quantities of 3.6 X 10^{-1} kg.ha^{-1}, when started a slowly vertical motion into the soil. After a month of application carbendazim presented potential to fast movement into the **Soils 2** and **3**, when compared with **Soil 1** movement, keeping close to the deepness near the surface (0.025 m in the first two mentioned soils and 0.016 m in the third one). Even at about 43 days of application, carbendazim presented potential to be found at a depth close to 0.084 m in quantities of the order of 10^{-1} kg ha^{-1} in all studied soils. Close to 51 days after application, the product overcomes the root zone initially in **Soil 2** and **3**, in amounts of 3.0 X 10^{-1} kg ha^{-1} for both soils, while in **Soil 1** the root zone was overcome only 63 days after the application (amount of 2.8 X 10^{-1} kg ha^{-1}). After 2 months, carbendazim enhanced its vertical movement to deeper soil layers on **Soil 2** (0.18m) and **Soil 3** (0.17m). 63 days after the application were registered amounts of 2.8 X 10^{-1} kg ha^{-1} for all soils, where the greatest depths were found in **Soil 3** (0.21 m) and **Soil 2**(0.22 m) followed by **Soil 1** (0.15 m). After one year of the application date, carbendazim remains at 0.56 m (**Soil 3**) and 0.42 m (**Soil 2**), in amounts around to 4.9 X 10^{-2} kg ha^{-1}. Even after 241 days of application, the product still showed potential to be found in significant quantities (in the order of 10^{-2} kg ha^{-1} in all soils), at 1.51 m (**Soil 3**), 1. 4 m (**Soil 2**) and 1.2 m (**Soil 1**). After two years of application, the product was found at 1.53 (**Soil 3**), 1.37 m (Soil 2) and 1.22 m (Soil 1), in amounts of 6.4 X 10^{-3} kg ha^{-1} in all soils. At the end of the simulation period (31/12/2005), carbendazim presented potential to reach 2.7 m depth but on quantities of 7.9 X 10^{-4} kg ha^{-1}; **c) Prochloraz** – The pesticide remained very close to the surface of all soils until 59 days of application (not exceeding 0.14 m) in quantities of 4.3 X 10^{-1} kg ha^{-1}. The product showed variation in its potential to overcome the culture root zone, reaching it earlier in **Soils 2** and **3** (at 62 days of the application) and afterward in **Soil 1** (at 79 days of application). After one year of the date of simulation beginning, the product still presented tendencies to be found in one meter depth in all soils evaluated, in significant quantities (7.2 X 10^{-2} kg ha^{-1}). Even after two years of the product application, prochloraz showed tendencies to be found at around one meter depth into all soils assessed (at a rate of 9.6 X 10^{-3} kg ha^{-1}). At the end of the simulation period, the product was found at 2 m depth in the **Soil 3** and close to 1.75 m in **Soils 1** and **2**, even registered quantities about 1.2 X 10^{-3} kg ha^{-1} in all studied soils; **d) Methamidophos** – The pesticide presented potential for remaining extremely close to the surface at all studied soil until 19 days after application (0.006 m in quantities of 6.7 X 10^{-2} kg ha^{-1}). Despite starting the vertical movement, still remained near the surface after 27 days of application, when quantities of 2.7 X 10^{-2} kg ha^{-1} were achieved. Methamidophos overcome the culture root zone after 29 days of application, when it showed potential to be found in slightly greater depth in the **Soil 3** (0.32 m) than the others ones, namely **Soil 2** (0.30m) and **Soil 1** (0.24m), in quantities in the order of 10^{-2} kg ha^{-1}. After 31 days of application, the product enhanced its vertical movement into the **Soil 3** (0.71m) and **Soil 2** (0.56m), when compared with **Soil 1**(0.47m). At 35 days after application, methamidophos showed potential to be found at 1.70 m (**Soil 3**) and 1.25 m (**Soil 2**), while at 1.03 m in **Soil 1**, on quantities in the order of 10^{-2} kg ha^{-1}. 48 days after the product application, it presented potential be found at 4.45 m (in amount of 2.3 X10^{-3} kg ha^{-1}) in **Soil 3**, and at depths of 3.2 m in **Soil2** and 2.9m in **Soil 1.** Even 53 days after the application the product showed potential to be found at 5.31 m depth, in quantity in order of 1.3 X10^{-3} kg ha^{-1} , in **Soil 3** while 3.76 m and 3.42 m dephts in **Soil 2** and **Soil 1**, respectively. Afterward, at 59 days of application, the product was reached at 6.0m, 4.2 m and 3.9 m depths, respectively at Soil **3**, **Soil 2** and **Soil 1**, presenting potential for quantities in the order of 10^{-4} kg ha^{-1} in all evaluated soils. After 75 days, methamidophos showed potential to be found at 8.3 m, 5.8 m and 5.4 m depths, respectively in **Soil 3**, **Soil 2** and **Soil 1**; all of them presenting quantities in the magnitude order of 10^{-4} kg ha^{-1}. Subsequently, despite of the fact that it has even been observed that the simulator indicates strongly leaching trends for the product, their registered remaining quantities not justify local monitoring; **e) Dimethoate** – The pesticide presented stronger potential for leaching in **Soil 3**, when compared to the others. After 19 days of application, dimethoate showed similar behavior in all evaluated soils, remaining on the soil surface (from 0.001 to 0.004 m depth and quantities from 9.0 X 10^{-2} to 4.0 X 10^{-2} kg ha^{-1}). Dimethoate presented potential to overcome the crop root zone around 28 days after application, in quantities in magnitude of 10^{-2} kg ha^{-1} in all soils, presenting depths ranging from 0.17 to 0.23 m in **Soil 2**, 0.16 to 0.23 m in **Soil 3**, and 0.18 to 0.22 m in **Soil 1**. However, after 31 days its vertical movement into the soil became more differentiated, remaining between 0.35 and 0.52 m in **Soil 3**, 0.34 and 0.45m in **Soil 2**, and 0.26 and 0.37m in **Soil 1**, with quantities varying from 10^{-3} to 10^{-2} kg ha^{-1}. From 45 days of application, dimethoate showed potential to intensify its leaching in **Soil 3** (reaching 3-4 m depth in quantity order of 10^{-3} kg ha^{-1}) while in the remaining soils the product still very close (between 2 and 2.5 m depth for both in quantities in the order of 10^{-3} kg ha^{-1}). At 2 months of application, dimethoate showed potential to be found between 4 and 4.5 m in the **Soil 3**, even in quantity in the order of 10^{-3} kg ha^{-1}, while in **Soils 1** and **2** between 3 and 4 m depths, in quantities ranging from 10^{-4} kg ha^{-1} to 10^{-3} kg ha^{-1}). After 67 days of application, no significant amounts of dimethoate were presented.

When it is considered the simulation done for the Espraiado catchment, the followed depths and remaining quantities were observed at the end of simulated period: a) default-data scenario (**scn2def**): 1.89 m depth and quantity of 0.12 kg ha^{-1}; b) local-data scenario (**scn1lab**): 2.78 m depth and quantity of 0.18kg ha^{1}. In general, it was observed that hexazinone presented greater mobility into the **Typic Euthorthox** soil when considered the local data scenario. Comparisons between both evaluated scenarios were presented at **Figures 2** and **3**. Significant variations were observed near 63 days after application, which increases after 95 days. At this moment, it was registered 0.82 m depth on the local-data scenario while in the other scenario 1.27 m. Afterward, significative pesticide amount were identified at 100, 135 and 162 days after application. When compared with the other scenario, greater lixiviation was registered for the local-data scenario, which can be explained by its less value of Koc that gave greater mobility characteristic. It is important to notice that the depths registered in both scenarios at the end of the simulated period do not presented potential for the product reaches the aquifer (40m), since the maximum depth observed was 3.0m. Take into account IPT [1994] information, despite the fact of the presence of water table varying from 0 to 20m, it was verified that the studied soil cultivated with sugar cane is presented only at one specific area of the catchment (with comprises almost 10% of its total area), where the water table depths varies from 10 to 30 m. So that, hexazinone has no potential trends to water table contaminations at **Typic Euthorthox** soil type present at the Espraiado catchment. Considering the surface water potential, it is important to notice that the greatest quantities of hexazinone had potential to be found at the surface soil layers, when considering both scenarios, during the first two months after application. Despite the small Koc value registered for the local-data scenario, its main organic matter content registered at 0-80 cm favored the greatest adsorption observed. In addition, when considering the local-data scenario it was observed that after 46 days of the application hexazinone presented potential to reach about 13 cm depth maintaining 82.5% of its initial applied quantity, where in the other scenario this same depth would be reached after 48 days remaining 70% of applied quantity. Thus, areas susceptible for the studied soil type run-off, in the period mentioned above, presented tendencies for surface water contaminations, which must be better investigated in local monitoring as well as laboratorial residues analysis.

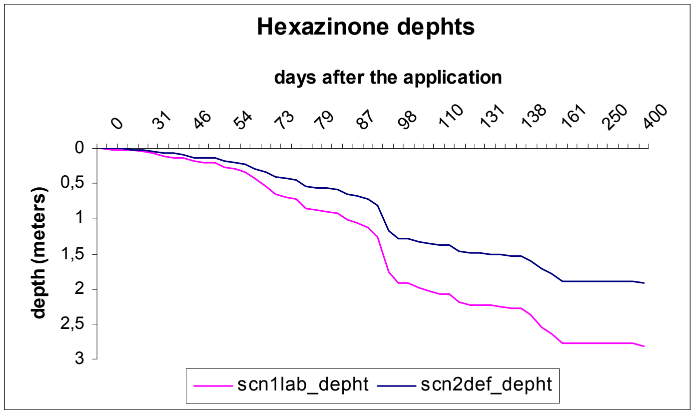


Figure 2. Simulation results for hexazinone depths.

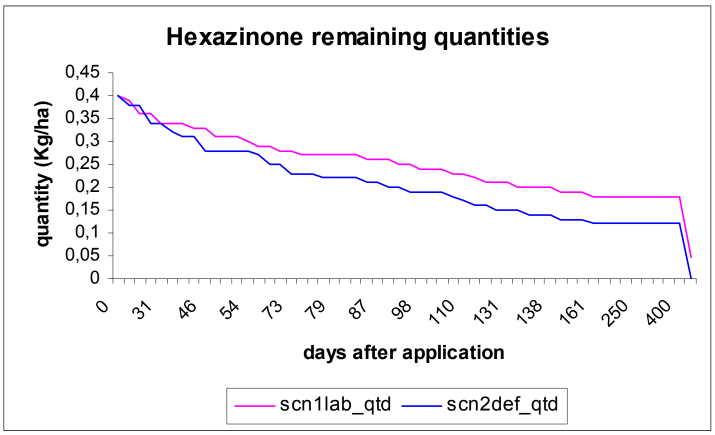


Figure 3. Simulation results for hexazinone remaining quantities.

4. CONCLUSION

The present study pointed out applications of CMLS94 for the Igarapé Cumarú and the Espraiado catchments in order to show their main trends for water risk contamination by pesticides, when considered yellow-passion fruit and sugar cane crops, respectively. When considering the Igarapé Cumarú simulated scenarios, the following trends were observed for: a) superficial water contamination trends: water and soil monitoring should be done for almost all evaluated pesticides, immediately after their applications until at least two months later (except for dimethoate, which must be done until one month after its application). If necessary to prioritize some of them, prochloraz and carbendazim must be selected due to their persistence observed by simulation along two years after the application date and their maintenance at superficial depths, when comparing to the other pesticides; b) groundwater contamination trends: according to simulations results, 2,4-D acid needs to be monitored along the first two months after its application date, due to its trend to reach 3m depth; methamidophos needs to be monitored mainly during 35 days after application, due it trends to be reached at 2m depth. All products had the main vertical movement into the **Soil 3**, despite that along the first months after application the dynamic observed by simulation indicated movements close to those reached for the **Soil 2**. None of the studied pesticides presented trends for potential contamination of the aquifer, when considered the saturated zone depth and the studied soils. When considered the Espraiado catchment, as main results we could mention that for: **a) Superficial water contamination trends:** It was observed that hexazinone had potential to remain close to the soil surface, mainly until 30 days after the application date. It was also noticed that the product could be reached after 46 days at 13 cm of depth, with 70-82.5 % of initial dose. This result indicates trends for potential risk to surface water contamination by run-off at this time**; b) Groundwater contamination trends: A**lthough the quantities remaining close on both scenarios, the main movement of hexazinone was observed for the local-data scenario, mainly at 63 days after product application. Despite the trends of hexazinone to be found at depth levels varying from 0 to 3 m, the simulated soil is not present at Espraiado catchments where these specific depths of water table could be found. Considering this fact, the potential risk of groundwater contamination of the aquifer (reached at 40 m) by hexazinone lixiviation in **Typic Euthorthox** soil type of the Espraiado catchment does not exist. The presented trends must be better investigated at local monitoring and its laboratorial water residue analysis. It is important to notice that CMLS94 does not permit to evaluate the residual effect from successive pesticide applications, which were not taken into account on the presented work.

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