Hydrosedimentological monitoring and modeling in paired watersheds in the Pampa biome

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INTRODUCTION

PRODUCTIVITY
\[ \times \]
SUSTAINABILITY

Naturally fragile areas used for forest production

- Fragile soils
- Soil tillage
- Extreme temperatures
- Water deficit

Sources: Research group collection
INTRODUCTION

Growth of *Eucalyptus* sp. in RS in the last decade: 184,2 thousand ha to 426,7 thousand ha (AGEFLOR, 2017)

- Relevant insertion in the Pampa biome;

Pampa biome

- Youngest Brazilian biome – 2004;
- Higher population density of grasses in the world (Oliveira et al., 2017);
- Environmentally fragile;

Replacement of native grassland by agricultural and forestry crops

Source: Oliveira et al., 2017

63% of RS territory
INTRODUCTION

• Deconfiguration of the natural landscape;

• Spatial and temporal changes in hydrological variables;

Unknown effect on environmental quality!
Studies in forest watersheds

1. Hydrosedimentological monitoring

   • Measurement of environmental variables in forest areas, and in areas with land use and management change, such as:
     • Infiltration
     • Surface runoff
     • Erosion

Sources: Research group collection
INTRODUCTION

Studies in forest watersheds

2. Use of mathematical models and scenarios simulation

- Identification of processes that negatively impact natural resources
- Identification of critical areas for the implementation of soil and water management practices
OBJECTIVES

To represent the behavior and to understand the dynamics of hydrological and sedimentological processes by monitoring and modeling with the Limburg Soil Erosion Model (LISEM) two small paired rural watersheds.
MATERIAL AND METHODS

Study area

- Two paired watersheds:
  - Land use based in eucalyptus plantation (EW, 0.83 km²);
  - Land use based in grassland (GW, 1.10 km²);

- Average altitude: 273 m;
- Climate Cfa, subtropical humid (Álvares et al., 2013), average annual temperature of 18.6 °C, reaching 31 °C in the warmest month and 5 °C in the coolest months;
- Average annual rainfall of 1356 mm;
- Predominant soil classes: Alisols, Cambisols and Regosols (Curi; Marques, 2011);
MATERIAL AND METHODS

Monitoring sections

- Linigraphs;
- Turbidimeters (Validation);
- Pluviographs;
- Central datalogger and solar panel
- Temporal discretization: 10 min.

Sources: Research group collection
MATERIAL AND METHODS

Mathematical modeling

Basic maps: soil, DEM, basin area, roads, drainage.

Table: soil properties, channel, road, and vegetation.

Simulation of hydrological events occurred using the LISEM model.

Sources: Research group collection

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RESULTS

Table 1: Hydrological variables measured (Mea) and simulated (Sim) for the two basins during the three simulated rain events.

<table>
<thead>
<tr>
<th></th>
<th>Date</th>
<th>Watershed with eucalyptus</th>
<th>Watershed with grassland</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12/01/19</td>
<td>15/02/19</td>
<td>16/03/19</td>
</tr>
<tr>
<td>P (mm)</td>
<td>29,956</td>
<td>31,496</td>
<td>29,464</td>
</tr>
<tr>
<td>P (mm)</td>
<td>12.9</td>
<td>11.7</td>
<td>11.7</td>
</tr>
<tr>
<td>Q_{peak} (L s^{-1})</td>
<td>157.7</td>
<td>37.8</td>
<td>12.0</td>
</tr>
<tr>
<td>Q_{peak} (L s^{-1})</td>
<td>175.365</td>
<td>41.778</td>
<td>14.427</td>
</tr>
<tr>
<td>T_{peak} (min)</td>
<td>380</td>
<td>230</td>
<td>590</td>
</tr>
<tr>
<td>T_{peak} (min)</td>
<td>390</td>
<td>240</td>
<td>590</td>
</tr>
<tr>
<td>SR (L)</td>
<td>555,727.3</td>
<td>139,799.5</td>
<td>52,628.8</td>
</tr>
<tr>
<td>SR (L)</td>
<td>655,854.9</td>
<td>113,478.3</td>
<td>56,109.0</td>
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<tr>
<td>SSC_{max} (mg L^{-1})</td>
<td>59.4</td>
<td>13.3</td>
<td>15.4</td>
</tr>
<tr>
<td>SSC_{max} (mg L^{-1})</td>
<td>51.0</td>
<td>8.0</td>
<td>5.0</td>
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<tr>
<td>S_{P_{total}} (Mg)</td>
<td>0.1175</td>
<td>0.030</td>
<td>0.0016</td>
</tr>
<tr>
<td>S_{P_{total}} (Mg)</td>
<td>0.0288</td>
<td>0.0008</td>
<td>0.0003</td>
</tr>
<tr>
<td>PBIAS SR</td>
<td>11.2</td>
<td>10.6</td>
<td>20.5</td>
</tr>
<tr>
<td>PBIAS SR</td>
<td>2.6</td>
<td>4.3</td>
<td>0.0</td>
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<tr>
<td>PBIAS SR</td>
<td>18.0</td>
<td>-18.6</td>
<td>6.6</td>
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<tr>
<td>PBIAS SSC</td>
<td>-14.16</td>
<td>-39.94</td>
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<tr>
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<td>-29.41</td>
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<td>PBIAS SSC</td>
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<tr>
<td>PBIAS SSC</td>
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<td>-74.9</td>
<td>-83.0</td>
</tr>
<tr>
<td>PBIAS SSC_{total}</td>
<td>-11.6</td>
<td>0.0</td>
<td>-26.3</td>
</tr>
<tr>
<td>NSE</td>
<td>0.56</td>
<td>0.65</td>
<td>-0.42</td>
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<tr>
<td>NSE</td>
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<td>-0.75</td>
<td>-1.70</td>
</tr>
<tr>
<td>NSE</td>
<td>-1.14</td>
<td>-0.75</td>
<td>-1.70</td>
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<tr>
<td>r^2</td>
<td>0.55</td>
<td>0.47</td>
<td>-0.27</td>
</tr>
</tbody>
</table>

Where: Precipitation (P); Maximum intensity of rain in one hour (P_{max, 1h}); Peak flow (Q_{peak}); Peak time (T_{peak}); Surface runoff (SR); Suspended sediment concentration (SSC); Sediment production (SP).
RESULTS

Figure 1: Precipitation, hydrograph and sedimentogram measured and simulated during the three monitored rain events for the basins with eucalyptus and grassland.
CONCLUSION

• LISEM satisfactorily represented the runoff in rainfall events of different intensities for both basins, supported by the Nash and Sutcliffe coefficients (> 0.50) and PBIAS or ERROR (< 25% for runoff and < 55% for the production of sediments).

• The model was unable to represent sediment production satisfactorily (< 0.50). This may be associated with spatial variability of the soil and the characteristics of the model used, which simulates the surface flow promoted by individual rainfall events in watersheds.

Our studies are in the early stages, continued monitoring is necessary to evaluate events of different magnitudes, and to identify a model capable of adequately representing the predominant subsurface runoff in forest areas.


OpenLisem 2020, https://blog.utwente.nl/lisem/