Hydrochemistry Change of Catchment in Tropical Rainforest Region of Hainan Caused by Forest Alteration

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1 Research sites
Hainan Island
Jianfengling Long Term Research Station of Tropical Forest Ecosystem (JLTRS) is one of National Key Field Station for Scientific Research & Experiment.
Branch station: Diaoluoshan
2 Methodology:

(1) Rainfall monitoring
(2) Runoff monitoring

Small watershed technology
Stream gauging tech.

Bashel trough

Odyssey™

V-Weir

Rectangle weir
Collecting data from data logging
(3) Sampling

a) Stream water samples collection in Diaoluoshan

- 5 times in Aug, Sep, Oct and 5 times in Dec and April in 2004.
- Collecting stream water samples of four different forested catchments in the same day when the weather is fine (no raining).
b) Water samples collection during typhoon storm in Jianfengling

- Collecting rainwater and stream water of two different forested catchments in the same day and same time.

Weather forecast
(4) Mensuration of water samples

Mensurating chemical component of water samples according to the national standard
CCD simultaneous ICP-OES [VISTA-MPX ]
离子色谱ICS-90
Ion chromatography system [Dionex]

UV-2450 UV-visible spectrophotometer [SHIMADZU]
3 Results

3.1 Stream water chemistry in Diaoluo

VTMR: Virgin tropical mountain rainforest;
RTMR: Regenerative tropical mountain rainforest;
RTLR: Regenerative tropical lowland rainforest;
RAP: Rubber & Areca Plantation.
Each numerical value in table is arithmetic mean value of 5 water samples.

### Table 1  Comparison of stream water chemistry in the different catchments with various tropical forests at Diaoluoshan tropical rainforest region

<table>
<thead>
<tr>
<th>Season</th>
<th>Rainy season</th>
<th>Dry season</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VTMR</td>
<td>RTMR</td>
</tr>
<tr>
<td><strong>pH</strong></td>
<td>6.63</td>
<td>7.24</td>
</tr>
<tr>
<td><strong>K⁺</strong></td>
<td>0.750</td>
<td>1.281</td>
</tr>
<tr>
<td><strong>Na⁺</strong></td>
<td>1.483</td>
<td>3.208</td>
</tr>
<tr>
<td><strong>Ca²⁺</strong></td>
<td>0.747</td>
<td>0.974</td>
</tr>
<tr>
<td><strong>Mg²⁺</strong></td>
<td>(0.194)</td>
<td>0.232</td>
</tr>
<tr>
<td><strong>PO₄³⁻</strong></td>
<td>0.006</td>
<td>0.006</td>
</tr>
<tr>
<td><strong>SO₄²⁻</strong></td>
<td>1.048</td>
<td>0.952</td>
</tr>
<tr>
<td><strong>Cl⁻</strong></td>
<td>5.082</td>
<td>4.953</td>
</tr>
<tr>
<td><strong>NO₃⁻</strong></td>
<td>0.054</td>
<td>0.042</td>
</tr>
<tr>
<td><strong>NH₄⁺</strong></td>
<td>0.004</td>
<td>0.001</td>
</tr>
<tr>
<td><strong>SiO₂</strong></td>
<td>7.387</td>
<td>9.886</td>
</tr>
<tr>
<td><strong>Sr</strong></td>
<td>0.0065</td>
<td>0.0198</td>
</tr>
</tbody>
</table>
That indicates more Mg$^{2+}$ was leached from forested catchment during the rain season, this maybe owing to that rainfall takes more Mg$^{2+}$ from ocean during wet-season than that in dry season.
3.2 Hydrochemistry of typhoon storm

Regenerated tropical mountain rainforest catchment (catchment A) and Chinese fir plantation catchment (catchment B) at Hainan Island’s Jianfengling
Table 2  The characteristics of the experimental watersheds

<table>
<thead>
<tr>
<th>Catchment</th>
<th>Area (ha)</th>
<th>Altitude (m)</th>
<th>Stream length (m)</th>
<th>mean width (m)</th>
<th>Shape coeff.</th>
<th>Tend of channel</th>
<th>Slope (°)</th>
<th>Parent rock</th>
<th>Soil type</th>
<th>Vegetation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3.01</td>
<td>826-1010</td>
<td>300</td>
<td>104</td>
<td>0.35</td>
<td>NEE</td>
<td>33.0</td>
<td>Porphyritic granite</td>
<td>Lateritic yellow soil</td>
<td>TMR</td>
</tr>
<tr>
<td>B</td>
<td>7.60</td>
<td>740-900</td>
<td>480</td>
<td>150</td>
<td>0.33</td>
<td>SEE</td>
<td>33.0</td>
<td>Porphyritic granite</td>
<td>Lateritic yellow soil</td>
<td>CFP</td>
</tr>
</tbody>
</table>
Total rainfall (CA/CB): 372.4 mm/413.9 mm

**About discharge**

Figure 1  Processes of discharge and rainfall for No. 9612 typhoon storm in different forested watersheds at Hainan's Jianfengling
The hydrological response (the ratio of quick flow to rainfall) of catchment B (34.29%) was 48.1% higher than that of catchment A (23.16%).

The maximum instantaneous recorded flood peak of B (0.1386 m³/s.hm²) was 22.2% larger than that of catchment A (0.1135 m³/s.hm²).
About hydrochemistry

There were two inverse types of hydrochemistry dynamics of stream-flow, one is: the pH value, especially the concentration of K and Si decreased as the rainfall intensity increased and, reached the lowest when the rainfall intensity reached the largest.
The other is: the element concentration of N, P, Ca, Mg, and Al were high during the storm and increased approximately as the rainfall intensity increased.
We can also find:

- Typhoon storm can accelerate obviously loss of nutrient, and better vegetation had a good function of alleviating this kind of nutrient loss or had a good mechanism of nutrient conservation. Tropical natural rainforest with fine structure can efficiently prevent the soil acidification caused by cation exchange during storm. In the same process of storm-hydrology, the concentration of main chemical elements such as N, P, K, Ca, Mg, Al and pH value in stream water of plantation watershed are 1.686, 2.859, 1.365, 1.018, 1.579, 3.921 and 1.210 times of that in tropical nature rainforest ecosystem respectively.

- Storm may be an important reason of phosphor deficiency in China’s tropics.
4 Conclusion

1) Although there are some exceptions, the concentrations of most chemical compounds increased in the order: VTMR < RTMR < RTL < RAP. That indicated that stream water quality is closely related with forest’s structure and disturbance of human and that the tropical rainforests had active effects for regulating and purifying stream water quality.
2) Except Mg$^{2+}$, Na$^+$, PO$_4^{3-}$, the pH-value and other chemical compounds in stream of the same forests during dry season are much higher than that during rain season.
3) There were two inverse types of hydrochemistry dynamics of stream-flow during typhoon storm, one is that the element concentration of N, P, Ca, Mg and Al were high during the storm and increased approximately as the rainfall intensity increased, the other is that the pH value, especially the concentration of K and Si decreased as the rainfall intensity increased and, reached the lowest when the rainfall intensity reached the largest.
4) Typhoon storm can accelerate obviously loss of nutrients in stream, and alteration of forest (from natural forest to plantation) will lead to the more serious loss of nutrients. Better vegetation had a good mechanism of nutrient conservation.
5 Discussions

- VTMR release more $\text{SO}_4^{2-}$, $\text{NO}_3^{-}$-N and $\text{NH}_4^+$-N during rain season than RTMR by runoff.
  Why? Limited (few data?)
Storm especially typhoon storm is an important reason of soil acidification & phosphor deficiency in China’s tropics

? Many factors; integrated analysis
The cause of hydrochemistry changes during typhoon storm is complex and need to do more analysis in coming research.
Thanks

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