Risk factors associated with practicing Mountainbiking on single-use bikepark trails

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Introduction

High social demand for outdoor activities observed in developed world, causes growth in any type of active recreation in natural areas. Dominating are running and jogging, fishing and biking, including mountainbiking (MTB), both in rate and frequency of participation. While average total level of participants in different sport disciplines remains constant (*Outdoor Participation Report, 2017*), rise in popularity of mountain resorts offering both winter and summer cable cars operation is observed (*Garibaldi at Squamish*, 2014). Significant share of summer-season offer in mountain regions is dedicated to MTB, which largely contributes to local economies (Boozer, Self, 2012).
MTB is recognised as sustainable, environmentally neutral outdoor activity. Current research proof, that impact is mostly short-term and connected with trail construction period (Allen, 2014). If the trail is built properly, than spatial extent of impact is reduced to narrow band of land, where erosion and accumulation processes occur and this part requires regular maintenance. Research shows, that influence on flora is minor, no major negative impact on fauna is observed as well (Quinn, Chernoff, 2010).

The research concept, method, scope and aim

The aim of the research is to verify if the long-term impact of MTB related to heavy-metal and hydrocarbons pollution is considerable and may require further investigation. Observing increase in demand for professionally established mountain cycling trails, we've asked questions concerning long-term impact of MTB on single-use trails. As most research focuses on macro-scale effects of MTB, such as soil erosion or habitat (plant and animal) disturbance, we decided to verify, if there's any traits of accumulation of heavy metals from worn brake pads and discs and hydrocarbons from tyre rubber in trail surface.
To analyse those aspects, a renowned MTB centre in Saalbach-Hinterglemm (Austria, Kitzbüheler Alps region) was selected. During research visits a questionnaire at local bike-rentals and services was carried, to find out what is the potential for heavy metals and carbohydrates delivery to trails per annum. Within 400-km long trail system, as sample objects to analyse, trails opened for use in different period and attracting different number of individual rides per day were identified. To confirm the number of users at trails, simultaneous manual counting at different trails was carried. From selected trails soil samples were collected in two rounds at the same spots: early season (beginning of July) and late

season (beginning of September). At each trail samples were collected from 4 or 5 spots at two points: first point was identified as intense braking area, just before the corner, second is the free-rolling section, when no braking occurs as the bicycle is accelerating. At each point, spots for collecting samples were located: at centre of trail (sample A), right and left edges of trail extent (sample B and C), 5 m from the edge of trail, where eroded rock material (subsoil) was collected (sample D) as a reference. In certain cases also sample E was collected, as a dry or wet deposit of trail material. The samples were prepared for chemical analyses in search for Aluminium, Zinc, Copper, Iron and Manganese, as a components of bike brake systems. Also other chemical analyses, such as pH and microelement levels were carried. A spectrometric analyses for search of hydrocarbons were carried as well. Total number of analysed samples reached 43.

Results, discussion

The questionnaire followed in local bike-services, shows annual demand for parts only for local rental bikes, that are used solely at local trail system, reaching 3000 tyres and 6000 sets of brake pads. The most commonly-used type of tyre is changed in rental bike when loses 120 g of rubber, which results in 360 kg material deposited in trail surfaces per year. Average semi-metallic set of brake pads losses 10 g of friction material before replacement, so there is 60 kg of brake-dust left on trails each year. Presented data show numbers only for rental bikes, it's hard to estimate data for private bicycles that are short-term used on local trails.

After verification, as sample objects the Hackelberg Trail (HacT), the Blue Line (BluL) and the Hohalm Trail (HohT) were selected. First two were made available for use as early as in 2000 (est.), the latter in 2013. The number of daily individual rides fluctuated from 14 at HohT to 2400 (!) at HacT during major event of MTB Festival, while at BluL numbers did not exceed 1400 users/day. At HohT samples were collected only during first study trip, as during summer season trail surface was modified.

Early results of chemical analyses indicate rise of selected heavy-metals in A-samples with reference to D-samples (table 1), specifically for braking points. Such strong relationship is not observed in samples for free-rolling points, although for Zn and Cu differences are significant. In seasonal section slight increase of heavy-metal levels are observed in the same spots, but this aspect requires further investigation. Spectral image of all A-, B- and C-samples shows presence of aliphatic hydrocarbons, while in most of D-samples hydrocarbons have not been detected. Further investigation is needed for analyses of hydrocarbons mobility, as not all E-samples show presence of them.

Results obtained can be affected by natural bedrock mineralogy. The study area is located within Western Greywacke Zone (WGZ), naturally rich in metallic elements (Kucha, Raith, 2009) and has long tradition of copper mining.

Sample number	Abbreviation	Al.%	Cu ppm	Fe%	Mn ppm	Zn ppm
1	**HacT1_1A**	**4,2198**	**26,9**	**3,3878**	**449,1**	**74,5**
4	*HacT1_1D*	*3,6136*	*5,1*	*0,6048*	*22,3*	*15,3*
11	**HohT1_1A**	**4,8701**	**11,3**	**3,0605**	**187,7**	**43,9**
14	*HohT1_1D*	*3,1783*	*5,5*	*0,6143*	*22,0*	*18,1*
20	**BluL1_1A**	**5,0920**	**20,9**	**6,9295**	**1070,6**	**95,4**
23	*BluL1_1D*	*5,4070*	*8,2*	*6,9520*	*690,8*	*79,5*
27	**HacT1_2A**	**4,1781**	**38,0**	**3,4437**	**403,1**	**79,1**
30	*HacT1_2D*	*3,9666*	*4,0*	*0,7536*	*50,9*	*16,0*
36	**BluL1_2A**	**5,0155**	**27,2**	**6,7295**	**974,7**	**98,7**
39	*BluL1_2D*	*5,0531*	*7,5*	*6,5732*	*684,6*	*74,8*

Samples collected at centre of trail

Reference samples

Table 1. Relation in heavy-metal levels between A- and D-samples at brake points.

Conclusions

Observed increase in heavy metals levels between A- (centre of trail) and D-samples (reference) and presence of hydrocarbons in spectrometric image, suggest the need of further investigation of long-term impacts of MTB at single-use trails. To be discussed is, whether received test results indicate any dangerous levels, what would be the migration traces for heavy metals and hydrocarbons and if indicated levels may impact flora and fauna or water resources. Issues rise also about the performance of different trail surfaces in accumulation of heavy metals and hydrocarbons. All above should be further translated into sustainable trail management practices.

References

Allen, B (2014) *Bike Parks: IMBA's Guide to New School Trails*, Boulder: International Mountain Bicycling Association.

Boozer, B., Self, M. (2012) *An Economic and Impact Analysis of the Coldwater Mountain Bike Trail*, Jacksonville: Center for Economic Development Jacksonville State University.

Garibaldi at Squamish - Comparative Analysis of Alpine Resort Activities (2014) Ketchum: SE Group.

Kucha, H., Raith, J. (2009) 'Gold-oxysulphides in copper deposits of the Greywacke Zone, Austria: A mineral chemical and infrared fluid inclusion study', Ore Geology Reviews, 35(2009), p. 87-100.

Outdoor Participation Report 2017 (2017) Washington DC: The Outdoor Foundation.

Quinn, M., Chernoff, G. (2010) *Mountain Biking: A Review of the Ecological Effects. A Literature Review for Parks Canada – National Office (Visitor Experience Branch)*, Calgary: Miistakis Institute, Faculty of Environmental Design –University of Calgary