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Climbing as a kind of human impact on the high mountain environment – based on the selected peaks of Seven Summits

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Abstract

For the last 40 years a significant increase in the number of high mountain climbers has been observed. It is connected with changing characteristics of the climbing activity and the climber's profile. Due to the commercial approach to the mountaineering, conquering the high mountains via normal routes is no longer seen as an extreme type of climbing, but as a form of trekking on the high altitude.

This article focuses on three examples chosen from Seven Summits: Denali, Aconcagua and Kilimanjaro - the most popular peaks among the climbers. Due to a huge number of climbers (respectively in 2007: Denali – 1218, Aconcagua – 4548 and Kilimanjaro – 41760) and the lack of education those people affect the environment and through that they disrupt natural ecosystem. Consequences of ecological imbalance include: destruction of vegetation, disruption of fauna, introduction of the new species (plants and animals), pollution by garbage and excrement, disruption of the natural landscape by tourist infrastructure, and noise etc.

Purity of the high mountains depends on two matters: management of mountain areas and climbers themselves (rule Leave No Trace). This paper indicates the negative impact of mountain climbing activity to the mountain environment and tries to find a good-practice of climbing management in mountain areas.

Key words: Aconcagua, Climbing management, Degradation, Denali, Kilimanjaro, Mountain environment.

1. INTRODUCTION

Mountains from ages fascinated people, mostly from two reasons: religious and secular. And because of that, mountains areas are after coastal regions second in global popularity as tourist destinations [1]. Times when people in the name of faith worshiped the highest mountain summits is almost gone [2]. Today, wanting to escape urban pollution, noise, crime and other related stress, people look to mountain environment for their serenity and relative calm [3]. This *escape* made mountain tourism a global social phenomenon and its impact on the environment an increasingly significant source of anthropopressure. The evolution of mountain climbing, from elite activity to the mass sport, caused losses and damage in natural ecosystem. To determine why this problem occurs, attention is focussed on the phenomenon of the Seven Summits and motivations of climbers.

2. STUDY AREA

The Seven Summits term refers to the highest mountains of each of the seven continents. However, there is not seven, but (at least) nine mountain to conquer (tab. 1). This inaccuracy comes from a different perception of scientists, climbers, politicians and other people about the boundaries and regions. Mostly in two cases. (1) In case of Europe this is a the border between Europe and Asia, and a choice between Mont Blanc in Alps or Elbrus on Caucasus Mountains. (2) Similar situation is in case of Australia. When qualifying Australia only as the core of the continent, the highest peak of that continent is Mount Kosciuszko, but when speaking about the region of Australia and Oceania the highest mountain is Puncak Jaya (Carstenz Pyramid) on Papua New Guinea. This controversy comes mostly from understanding that Seven Summits term was made up by climbers not scientists. To defence this claim, note that there is no Mont Blanc on the list of Seven Summits which according to International Geographical Union not only lies in Europe, but is the highest peak of that continent. To understand this discrepancies it is necessary to go back in time to the history of mountaineering in that particular aspect.

Table 1. Seven Summits List in two most popular versions.

Bass list	Messner list	Summit	Elevation [meters]	Continent	Range	Country	First successful ascent
✓	✓	Kilimanjaro	5895	Africa	Kilimanjaro	Tanzania	1889
✓	✓	Vinson Massif	4897	Antarctica	Ellsworth Mountains	N/A	1966
✓		Mount Kosciuszko	2228	Australia	Great Dividing Range	Australia	1840
	✓	Puncak Jaya (Carstenz Pyramid)	4884	Asia	Maoke Mountains	Indonesia	1962
✓	✓	Mount Everest (Chomolungma/Sagarmatha)	8850	Asia	Himalaya	China/Nepal	1953
✓	✓	Elbrus	5642	Europe	Caucasus	Russia	1874
✓	✓	Denali (Mount McKinley)	6194	North America	Alaska Range	USA	1913
✓	✓	Aconcagua	6960	South America	Andes	Argentina	1897

The first conqueror of what we name today Seven Summit, and also an author of that term was American multimillionaire Richard “Dick” Bass, who as an amateur mountaineer set himself the goal to climb the highest mountain on each of the seven continents. However the originator of the idea, was not Bass but other American - William D. Hackett. Due to several circumstances (lack of funds, frostbite, etc) Hackett

climbed *only* five mountains (chronologically: Denali¹, Aconcagua, Kilimanjaro, Kosciuszko, Mont Blanc). Bass completed Seven Summit quest in 1985; by climbing (chronologically): Denali, Aconcagua, Elbrus, Kilimanjaro, Mount Vinson, Mount Kosciuszko and Mount Everest. However, R. Bass list was immediately questioned by famous Italian mountaineer Reinhold Messner (the first climber to ascend all fourteen eight-thousanders which lies in Karakokum and Himalaya Range). R. Messner, who wanted to be a first conqueror of *real* Seven Summits (in his opinion) replaced Australian's Mount Kosciuszko with Indonesia's Puncak Jaya. However first person who completed Messner list, before Messner himself, was Canadian mountaineer Pat Morrow (May 7, 1986). Differences on determining highest peak of Australia or Australia and Oceania gave two lists, named after the originators 'Bass list' and 'Messner list' (also called Carstensz list). Note that, neither the Bass or the Messner list include Mont Blanc. Well known S. Bell's book *Seven Summits - The quest to Reach the Highest Point on Every Continents* also did not even mentioned about Mont Blanc [4]. However most of the mountaineers who want to complete the Seven Summits Quest also climb Mont Blanc, just in case.

A. Hajzer [5] among the criteria for selection of the Seven Summit peaks indicates:

- 1) physical and geological criteria,
- 2) political criteria,
- 3) others, such as, attractiveness and difficulty of climbing, historic and cultural factors, collusion of tourism industry lobby and the opinion of authorities.

According to those criteria, it is not surprising that confused mountaineers, to be safe, climbs nine summit. However there are some, also scientists who are convinced that there are only five (like symbol of the Olympic Games which composed of five interlocking rings), three or even one continent. Also Antarctic, when look closer, without the ice cap is not the real continent but archipelago. And more important than that fact is that Mount Vinson would be placed not on the main island, but on some small one. A. Hajzer ironically concludes: *we have XXI century, we fly into space, and we do not even know how many continents we have on our beautiful Earth?*

This research area, however focus on mountains from the Seven Summit list which are common ground for all, both climbers and scientists. To show topic of this work three peaks were chosen: Denali (Mount McKinley) on North America, Aconcagua on South America and Kilimanjaro on Africa (fig. 1).



¹ The author is convinced of the superiority of the name Denali above Mount McKinley - already in 1975, the Alaska Board of Geographic Names changed the name of the mountain to Denali. Currently, legislative work in the United States Senate (including Senate Bill 155 from 10 of September, 2013) regarding to this changing.



Figure 1. Figures represent the most popular routes (normal routes) leading to the summit (from left): Denali – West Buttress, Aconcagua – North West Ridge and Kilimanjaro – Marangu Route (Source: compiled by the author, Google Maps).

3. GROWTH IN NUMBERS AND CLIMBER'S PROFILE CHANGE

Seven Summits, the tallest and the best-know peaks on each continent, attracts a large numbers of climbers each year. Figure 2 represent the number of climbers who tried to climb Denali, Aconcagua and Kilimanjaro in each year during period between 1990-2007. Numbers have grown to reach (respectively) 1218, 4548, 41760 climbers per year in 2007.

With the development of extreme sports people were heading to the mountains in search of new, often strong emotions and sensations. It is quite difficult (if not impossible) to specify reasons why people merge their life with high mountains. Generally, today there are two kind of people on the high mountain stage. Both groups are guided by different motives, and according to A. Maslow's [6] hierarchy of needs there are; self-sufficient climbers (*self-actualization*) and climbers using the services of paid guides (*esteem*) [7].

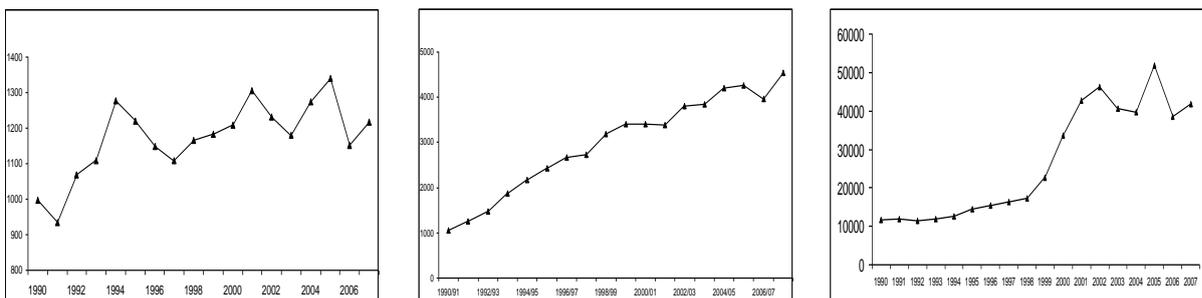


Figure 2. Changes in the number of tourists in period between 1990-2007 who wanted to climb (from left): Denali, Aconcagua and Kilimanjaro (Source: Apollo 2010).

Recently the number of climbers increased drastically. This is caused by two aspects: (1) evolution of climbing techniques and increasing physical capabilities of climbers and (2) commercial approach to this kind of activity. An increasing number of mountain climbers affects mountain environment; it affects both people (local communities) and nature (fig. 3).

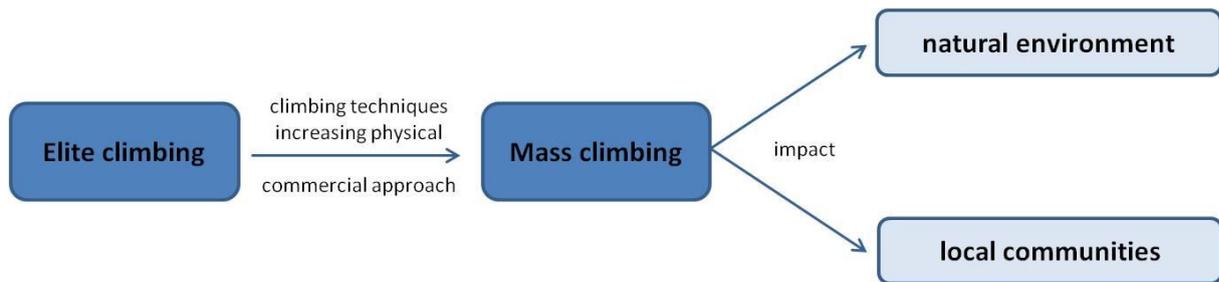


Figure 3. Climbing evolution and its impacts

Before the period of intensive development mountain climbing was treated as a kind of elite activity. Ethical principles, including the principles of conservation was an important part of the ethos of climbing. Unfortunately, more often *real* climbers are replaced by tourists with *oversized ambition*, aptly described by P. Morawski [2]. Mountain climbing has become a mass sport, and thus the characteristic of climbing activity and the climber's profile have changed very much. Commercial approach (agencies fees, governments permits) made that on some popular summits, like Seven Summits there can be found only rich tourists. Rich, because to gain Seven Summits need to have around 200,000 USD. This business is so big that nobody cares about impacts on natural environment and also that this kills the real spirit of mountaineering.

4. EXAMPLES OF IMPACTS

Problems on environmental impact by broadly defined climbing activity is relatively very poorly understood, mostly because research polygons are difficult to access (researches need to use climbing techniques). On the other hand traditional research methodology in faculty of biology or geography unfortunately fails in case of mountain environment [8]. There were many research studies dealing with the human impact on wildlife. Nevertheless, the impact of high-mountain climbers is poorly explained so far. Below there are presented some examples of climbers impact to natural environment of Aconcagua, Denali and Kilimanjaro.

4.1. Disruption of flora and fauna, and introduction new species (plants and animals)

Vegetation and wildlife are the main natural features altered by climbers. The mechanical damage of plants and disturbance of animals are most common impacts. Scale of transformation is quite big, because most of the times climbing season coincides with vegetation season. For example the main climbing season on Aconcagua runs from November 15 to March 15, which is a summer (December 1 - February 28/29) in the southern hemisphere, and thus plants and animals have very short time for reproduction even without people disturbing (fig. 4). Climbers, as well as all people visiting mountains destroy plants by trampling. Less than a few studies have been done about trampling and vegetation response on mountain areas, eg in USA by D. Cole [9] and in Himalayas by M. Apollo (not yet published). Therefore, all plants around camps were destroyed, eg. a whole area (ring $\varnothing=25$ meters) of the first camp on Aconcagua - Confluencia - is devoid of any vegetation [10]. However, outside the camps area occurs

a ring of abundant vegetation, which is probably related with tourists, and more specifically with the products of their urination. This relationship describes the work of J.B. Kirkpatrick [11].

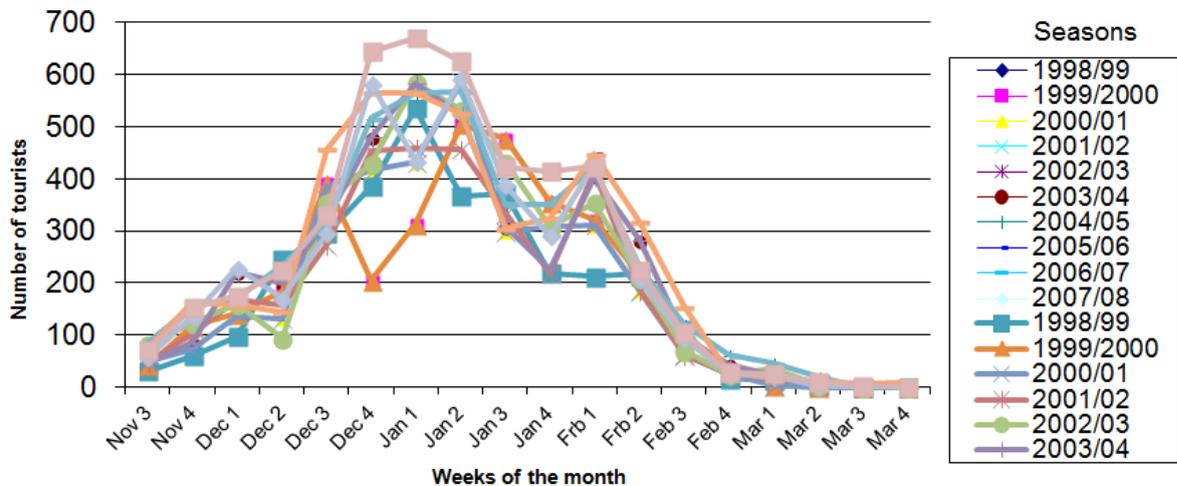


Figure 4. The number of tourists staying in the Aconcagua massif different in seasons in a period of time 1998/99 - 2007/08.

As opposed to Denali (the whole mountain is on the nival level), on Kilimanjaro and Aconcagua tourism introduce new species of plants and animals. This is done directly or indirectly. Example of the both influences can be found on Aconcagua. Direct impact can be found on early expansion, which almost completely eliminated all bushes (fuel wood). Bushes which were used by many species of avifauna as nesting places, eg. Buff-necked Ibis (*Theristicus caudatus*). Intentionally or accidentally people introduced exotic species like European hare (*Lepus europaeus*) or rainbow trout (*Oncorhynchus mykiss*). Pollution of surface waters mostly by phosphorus and nitrogen leads to eutrophication of the lakes (Algae) and thus flora and fauna of lakes is changing. On the other hand, indirect impact concerns mules which are used for transportation of climbing equipment. Most of mules spends a free time and overnight on grazing on lower elevation. Later the seeds contained in their droppings are spread at a higher altitudes, and thus mules introduce new species of plants. The most common exotics are: field bindweed (*Convolvulus arvensis*), common dandelion (*Taraxacum officinale*), hedge mustard (*Sisymbrium officinale*), saltcedar (*Tamarix ramosissima*) [10].

4.2. Pollution by garbage and excrements

The practice of dumping unwanted materials might not be a problem if rapid breakdown of such materials occurred, if campsites were large in relation to the numbers of users, or if the number of users were small [12]. Unfortunately, this happen very rarely, especially on popular summits (fig. 2). Alpine regions have typically slow decomposition and decay of materials. Several researchers as well as many climbers noted, that on high elevation even paper may take several years to disintegrate, and discarded cans may remain intact for many decades [12].

Kilimanjaro, one of the most busiest mountain in the world for many years was called white mountain after glaciers flowing down from the top, but recently many people call

it dirty mountain. During the period between 1977-2007 Kilimanjaro National Park has been visited by more than half a million people. It is clear that after 627,976 tourists will be a lot of garbage [7]. In 1993, two ordinary tourists during their climbs by Marangu Route, which is the most popular route on Kilimanjaro collected approx 4500 pieces of garbage (include all kinds of packaging, cigarette butts, wrappers, plastic bottles and other). It is worth to note that there was garbage raised from the path only [13]. With the increase of number of tourists the size of garbage also has increased, from 87 tons in 2003 to 125 tons in 2006. However, the authorities has improved efficiency of garbage disposal from 64% in 2003 to 94% in 2006 [14].

Table 2. Comparison of four garbage disposal practices (after Cullen 1986).

	Feasibility	Effectiveness	Cost to expedition	Comments
Burn	Usually high	Incombustible material remains	Low	Incomplete solution
Cover with rocks etc.	Usually high, but not feasible on snow- or ice-covered sites	Low if subsequently uncovered	Modest effort cost	Unsatisfactory unless very thoroughly covered
Bury in crevasse	High if near sustainable crevasses	Good until materials subsequently reappears	Low effort cost if near crevasse	May be only practical policy available on glacier sites
Bury on or of site	High if ground is suitable for digging pits	Good in well-chosen and – managed sites	Effort and transport costs may be high	Best solution if well managed

Purity in high mountains depends mainly on climbers visiting them (rule Leave No Trace), however, no climber can be blamed for leaving behind human faeces (if there is no special treatment), because the process of excretion can not be stopped. If the administrator of mountain regions will not do anything with that base case, some of the cleanest areas of the world will change forever. Every mountain from Seven Summit List is different in many ways, so each management has to find own way of disposal human faeces. In the recent years the number of climbers who try to climb at least one peak from the list has increased dramatically, so disposal of human waste has become a huge problem. Unfortunately not every mountain management like Kilimanjaro National Park, Aconcagua Provincial Park or Denali National Park are doing fine (tab. 3).

Based on the formula elaborated by M. Apollo [15] it was calculated quantitative values of human faeces and urine remaining after climbers per year in 2007. According to this research and calculations only in 2007, there remained on Denali (tab. 4), Aconcagua (tab. 5) and Kilimanjaro (tab. 6) (respectively): 700 kg (39,500 l), 582 kg (57,000 l) and 9 t (0.5 million l) of faeces (urine) after climbers. These numbers can not be trivialized, mostly because human waste carry harmful micro-organisms and leaving them in natural areas can result in contamination of water supplies and soils, and lead to diseases [15]. As example, the salmonella bacterium that infects many species of animals may survive in the environment for a long time. Studies show that buried 20 cm below the surface of the earth it can survive up to 51 weeks [16]. Also, they look very unpleasant.

Table 3. Human feces and urine remaining on chosen peaks of Seven Summits in a period of time 1990-

2007 (after Apollo 2014).

Summit	No of climbers in a period of time 1990-2007	Feces [kg]	Urine [l]
Denali	21,125	12,168	684,450
Aconcagua	53,676	6,870	386,467
Kilimanjaro	480,195	107,563	6,050,457

Table 4. Human feces and urine remaining on Denali after 1218 tourists in 2007 (after Apollo 2014).

Camp	Toilet	Residence time in the camp	Feces [kg]	Urine [l]
I	Yes	3	116.928	6,577.2
II	No	1	38.976	2,192.4
III	No	2	77.952	4,384.8
IV	Yes	8	311.808	17,539.2
V	No	4	155.904	8,769.6
Total			701.568	39,463.2

Table 5. Human feces and urine remaining on Aconcagua after 4548 tourists in season 2006/2007 (after Apollo 2014).

Camp	Toilet	Residence time in the camp	Feces [kg]	Urine [l]
I	Yes*	3	436.608*	57,304.8*
II	Yes*	8	1,164.288*	16,372.8*
III	No	1	145.536	16,372.8
IV	No	2	291.072	8,186.2
V	No	1	145.536	4,093.2
Total			582.144	57,304.8

*not included in total - 100% excrements are removed from this toilets out from the mountain.

Table 6. Human feces and urine remaining on Kilimanjaro after 41760 tourists in 2007 (after Apollo 2014).

Camp	Toilet	Residence time in the camp	Feces [kg]	Urine [l]
I	Yes	1	1,336.32	75,168
II	Yes	2	2,672.64	150,336
III	Yes	3	4,008.96	225,504
IV	Yes	1	1,336.32	75,168
Total			9,354.24	526,176

According to D.N. Cole *at al* [17] its recommended few strategies for managers when dealing with human waste:

1. Reducing use (prohibiting or limiting the numbers of visitors),
2. Modifying the location of use (locate facilities on durable sites),
3. Modify type of use and visitor behavior (education),
4. Increase resistance of the resource (provide sanitation infrastructure),
5. Maintain or rehabilitate the resource (remove waste from toilets),
6. Punish for breaches of the rules (high fines).

5. THE TYPES OF INTERACTIONS AND THEIR CLASSIFICATION (TYPOLOGY)

According to Access Fund human impact zones in climbing areas can be divided into 6 zones: (1) the approach zone, (2) staging area, (3) the climb, (4) the summit, (5) the descent zone, (6) camping or bivouac [18]. In each zone climber can affect on natural environment by:

- a) anthropogenic landslides
- b) anthropogenic microforms on rocks
- c) trampling
- d) vegetation damage
- e) introducing new species (plants and animals)
- f) disturbance or attracting animals
- g) disruption of the natural landscape by tourist infrastructure
- h) left behind climbing equipment
- i) pollution by garbage and excrements
- j) noise.

And through it affects the main elements the natural environment: geological substrate, land relief, water, vegetation cover, soil, fauna and the landscape. Figure 5 shows complex system of environmental impacts caused by climbers.

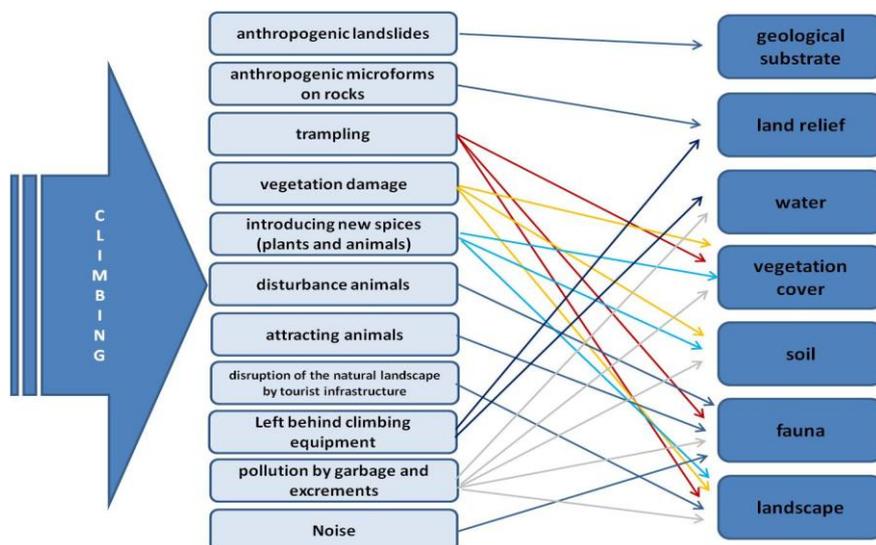


Figure 5. Complex system of environmental impacts caused by climbers

4. CONCLUSION

Researches about fragile mountain environment are very important. Mostly because once injured such environment will suffer for ages. The lack of understanding of the nature conservation methods leads to disobeying the restrictions, which are considered to be oppressive and irrational. Only cooperation between authorities and climbing organizations is a crucial point determining the efficiency of management process. Workshops, conferences, fieldtrips and climbing schools create a excellent opportunities to share the knowledge on both nature conservation and climbing activity [8]. If we

want to keep mountains nature and wildlife in today's conditions for other generations we have to develop ways to control. However, if control is suppose to act correctly it have to be composed of two factors:

1. Control by authorities - respected and enforced set of rules, however supported by studies and based on system solutions.
2. Self control - the information on all restrictions should be quite well accessible on websites, in guidebooks, and as well as directly in the field (billboards, signs, etc).

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